TS
227
.R1
W39

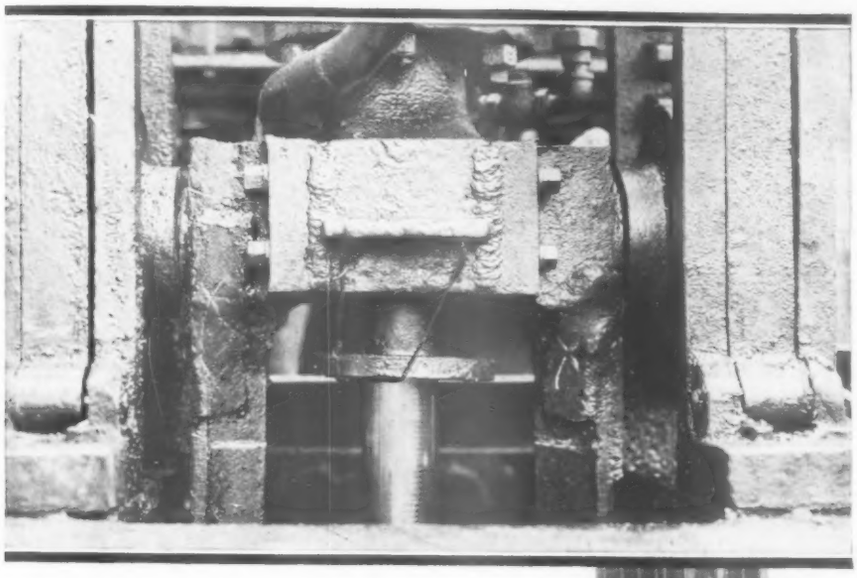
The Welding Engineer

Reg. U. S. Pat. Office

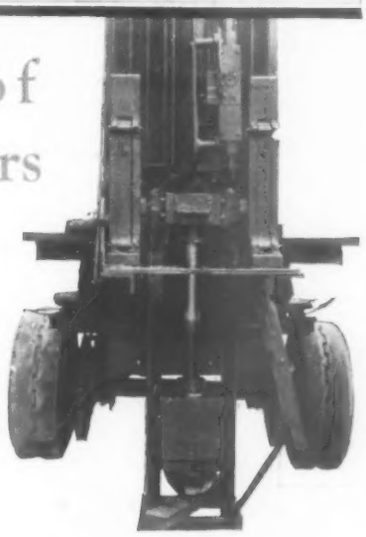
Founded by L. B. Mackenzie, 1916

MARCH, 1930 VOL. 15, NO. 3

$3.00 per year in U. S. 608 S. Dearborn St., Chicago, Ill. $4.00 per year abroad



FAST WORK of Wilson Arc-Welders Saves Costly Delay



Above: Close-up view showing how hammer guides on Concrete Pavement Breaker were completely repaired by Wilson Arc-Welder.

"WHILE breaking up a stretch of pavement on Waukegan Road with one of our new type pavement breakers, we broke the hammer guide. If it had not been for the quick and efficient method of your arc welding job, it would have meant quite an expensive delay, not only to us, but to the well-regulated paving crew. * * We certainly must admit that electric arc welding has saved us a lot of expensive delays and made a good permanent repair." — *Chicago Concrete Breaking Company.*

Both in production and repair work, Wilson Arc Welding Machines are reducing costs—directly and indirectly. Pioneers in arc welding—Wilson, with their long experience and great accumulation of welding knowledge, invites you to consult freely with their engineers.

Whatever YOUR industry —whatever YOUR metal-joining problem —investigate ARC-WELDING

WILSON WELDER & METALS CO. INC., 20 WILSON BUILDING, HOBOKEN, N. J.

WILSON

WELDING MACHINES AND WELDING WIRE

Published monthly by the Welding Engineer Publishing Co. Entered as second class matter Jan. 20, 1916, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

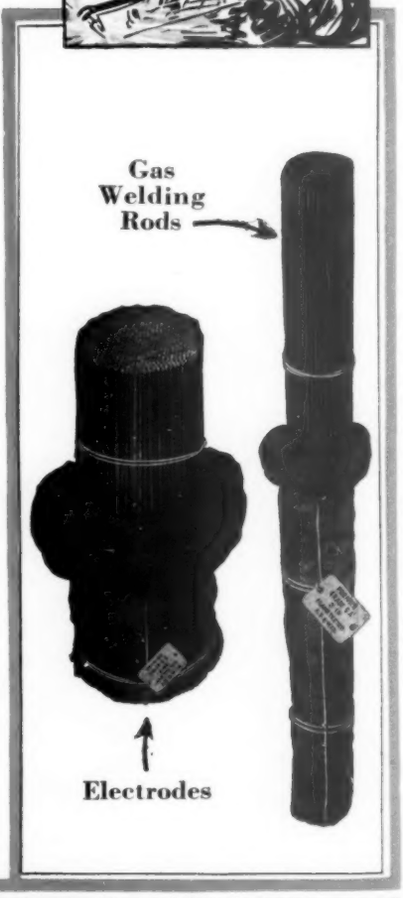
Tested.... to Assure Better Welding

THE best way to be certain of the welding wire you buy—to assure highest quality and low shop costs—is to specify a brand that has a proved record back of it.

Premier Welding Wire, made only by the American Steel & Wire Company, has clearly demonstrated its superiority under the most severe of service conditions. Constantly uniform in its structure, always free flowing and deeply penetrating, it is free from harmful impurities and provides a weld of maximum strength.

Each bundle, gas or electric, is tested to insure its general efficiency. As a result spoiled work is eliminated and valuable time saved.

Today—write us about your welding problems. You will not be obligated.



PREMIER

TESTED

WELDING WIRES

AMERICAN STEEL & WIRE COMPANY

208 S. La Salle St., Chicago — SUBSIDIARY UNITED STATES STEEL CORPORATION — 30 Church St., New York

Other Sales Offices: Atlanta, Baltimore, Birmingham, Boston, Buffalo, Cincinnati, Cleveland, Dallas, Denver, Detroit, Kansas City, Memphis, Milwaukee, Minneapolis-St. Paul, Oklahoma City, Philadelphia, Pittsburgh, Salt Lake City, St. Louis, Wilkes-Barre, Worcester

U. S. Steel Products Co.: San Francisco, Los Angeles, Portland, Seattle, Honolulu

Export Distributors: United States Steel Products Co., 30 Church St., New York City

The Welding Engineer

Founded by L. B. Mackenzie, 1916

Volume 15 | March, 1930 | Number 3

CONTENTS

Inspection for Welded Construction 35
By John B. Hendrickson

Welded Steam-Heating Systems 37
By Webster Tallmadge

Repairing and Rebuilding Mill Motors 41
By J. L. Brown

Preheating Principles and Practice 43

Safety in Resistance Welding 47
By J. W. Meadowcroft

Structural-Steel and Pipe Welding 49
By O. A. Tilton

Hints for the Welder 53

Everybody's Business 31

Editorial 33

Welding Makes Tight Job in Dry-Ice Plant 40

Ship Tank Tops to Be Welded 42

British to Investigate Structural Welding 48

Prison Cells Without Bolts or Rivets 48

Strengthening Roof Girders by Welding 51

Huge Welded Truss for Mausoleum 62

New Products 64

New Literature 66

News of the Industry 68

1930 Still Looks Good

ALTHOUGH there has been considerable attention paid to the unemployment situation during the first two months of this year and although this situation may probably be interpreted as an indication that industrial activity was somewhat slowed up in the first months of the year, there does seem to be no reason to doubt the prospects for a good business year as far as the welding industry is concerned. Reports come from all directions, showing the possibilities of the greater use of welding on account of an increased knowledge of how to use welding to good advantage. Several manufacturers in the equipment field have indicated a gratifying increase in business, particularly in the case of new items which contain marked improvements over previous models. Publishers of *The Welding Engineer* find the current month to be the biggest month in the history of the business. The average volume of advertising is considerably higher than it was a year ago and is constantly increasing. In addition to this, the circulation department has discovered a greater percentage of response to circulation effort than has existed since the war. As a consequence, the list of paid-in-advance subscribers to *The Welding Engineer* is rapidly mounting at a rate which shows no sign of slowing up. These are all very good indications of the immediate future.

Published on the 15th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.
608 S. Dearborn St., Chicago, Ill.
Telephone WEBster 7134

G. H. Mackenzie ..... President and Treasurer
H. S. Card ..... Secretary

H. S. Card ..... Editor
F. L. Spangler ..... Managing Editor
C. T. Price ..... Associate Editor

Eastern Office—222 American Circle Bldg., New York. T. E. DePew, Eastern Manager. Telephone, Columbus 7843

East Central Office—
706 Engineers Bldg., Cleveland, Ohio, R. A. McCarthy, Representative

Subscription payable in advance and postage free.
United States and possessions and Canada ..... $3 a year
Foreign Countries ..... $4 a year
Single copy, domestic ..... 25 cents
Single copy, foreign ..... 30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 12th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails. All copy should be in by the 12th of the month at the latest.

The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

Authorized Representatives

CLEVELAND—R. K. Randall, 2261 E. 14th St.
DENVER—A. G. Odell, Public Opportunity School.
GREAT BRITAIN—Capt. D. Richardson, 26 Winterbrook Road, Herne Hill, London.
AUSTRALIA AND NEW ZEALAND—R. Hill, Matlock House, Davenport, Auckland, New Zealand.
SOUTH AFRICA—J. W. Arnison, 35a Victoria Ave., Benoni, Transvaal, South Africa.

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
Commercial Acetylene Supply Co.
Kansas City Oxygen Gas Co.
Modern Engineering Co.
International Oxygen Co.
Prest-O-Lite Co.

ACETYLENE CYLINDERS
Pressed Steel Tank Co.

ACETYLENE WELDING WIRE
Air Reduction Sales Co.
American Brass Co.
American Steel Engineering Co.
American Steel & Wire Co.
Atlas Foundry Co.
Central Steel & Wire Co.
Craftsweld Equipment Co.
Edgcomb Steel Co.
Fusion Welding Corporation
Hollup Corp.
Igoe Brothers
Imperal Brass Mfg. Co.
Kansas City Oxygen Gas Co.
Koro Corporation
Mueller Brass Co.
Oxweld Acetylene Co.
Page Steel & Wire Co.
Reid-Avery Co.
Roebling, John A., Sons Co.
Seneca Wire Mfg. Co.
Standard Steel & Wire Co.
St. Paul Welding & Mfg. Co.
Steel Sales Corp.
Stoody Co.
Joseph T. Ryerson & Sons, Inc.
Taylor-Wharton Iron & Steel Co.
Torchweld Equipment Co.
Wickwire Spencer Steel Co.
Welding Service Co.
Weldit Acetylene Co.
Williams & Co.

ALUMINO-THERMIC WELDING
Metal & Thermit Corporation

ALUMINUM SOLDER
Crown Aluminum Solder Co.

ANNEALING FURNACES
General Electric Co.
Westinghouse Elec. & Mfg. Co.

APRONS (Asbestos)
Ideal Face Shield Co.
Olympic Glove Co.

ASBESTOS INSULATED WIRE AND CABLE
Central Steel & Wire Co.

BENCHES, WELDING
Standard Pressed Steel Co.

BLOW PIPES
See "Torches"

BOOKS
The Welding Engineer Pub. Co.
General Electric Co.
Lincoln Electric Co.
Linde Air Products Co.
Electric Arc Cutting & Welding Co.

BRAZING OUTFITS
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
General Welding and Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Kansas City Oxygen Gas Co.
K-G Welding & Cutting Co.
Lotan Research Corp.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Sight Feed Generator Co.
Torchweld Equipment Co.
Victor Welding Equipment Co.
Williams & Co.

BRONZE FILLER RODS
American Brass Co.
Bridgeport Brass Co.
Central Steel & Wire Co.
Chase Brass and Copper Co., Inc.
Imperial Brass Mfg. Co.
Lotan Research Corp.
Mueller Brass Co.
Oxweld Acetylene Co.
Steel Sales Corp.

BUFFERS
R. G. Haskins Co.
Keller Mechanical Engineering Corp.
N. A. Strand & Co.

BUTT WELDERS
See "Electric Resistance Welders"

CABLE (Arc Welding)
Allan Mfg. & Welding Co.
Central Steel & Wire Co.
Fusion Welding Corp.
Electric Arc Cutting & Welding Co.
General Electric Co.
Hobart Bros.
Thomson-Gibb Welding Co.
Hollup Corp.
Lincoln Electric Co.
Quasi-Arc, Inc.
John A. Roebling Sons Co.
Joseph T. Ryerson & Sons, Inc.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

CARBIDE
Air Reduction Sales Co.
National Carbide Co.
Shawinigan Products Corp.
Union Carbide Sales Co.

CARBON (Blocks, Paste, Electrodes, etc.)
Air Reduction Sales Co.
Central Steel & Wire Co.
Electric Arc Cutting & Welding Co.
National Carbon Co.
Oxweld Acetylene Co.

CARBON BURNING EQUIPMENT
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Kansas City Oxygen Gas Co.
K-G Welding & Cutting Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
Victor Welding Equipment Co.

CAST IRON SOLDER
Crown Aluminum Solder Co.

CAUSTIC POTASH
Innis, Speiden & Company

CUTTING ELECTRODES (Electric Arc)
Allan Mfg. & Welding Co.
Arcos, Inc.
Electric Arc Cutting & Welding Co.
Fusion Welding Corp.
General Electric Co.
Lincoln Electric Co.
National Carbon Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

CYLINDERS (Acetylene)
Pressed Steel Tank Co.

CYLINDERS (Oxygen, Hydrogen)
Chas. L. Gulick
Harrisburg Pipe & Pipe Bending Co.
Wm. Wharton, Jr., Co.

DRILLS, PORTABLE ELECTRIC
R. G. Haskins Co.
Keller Mechanical Engineering Corp.
Stoody Company
N. A. Strand & Co.

ELECTRIC ARC WELDING OUTFITS
Allan Mfg. & Welding Co.
American Steel Engineering Co.
Burke Electric Co.
Electric Arc Cutting & Welding Co.
Electric Welding Machine Co.
Electrical Equipment Co.
Fusion Welding Corporation
General Electric Co.
Goodman Electric Machinery Co.
Hollup Corp.
Hobart Bros.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Joseph T. Ryerson & Sons, Inc.
Shrader Electric Co.
Stoody Co.
Thomson-Gibb Welding Co.
Waters Welders, Inc.
Welding Service Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRIC RESISTANCE WELDERS
American Transformer Co.
Federal Machine & Welder Co.
General Electric Co.
Gibb Welding Machines Co.
Goodman Electric Machinery Co.
Rhason Mfg. Co.
Joseph T. Ryerson & Son
Taylor-Winfield Co.

ELECTRODES (Carbon Arc Welding)
See "Cutting Electrodes"

ELECTRODES (Metallic Arc Welding)
American Steel & Wire Co.
American Steel Engineering Co.
Atlas Foundry Co.
Central Steel & Wire Co.
Edgcomb Steel Co.
Electric Arc Cutting & Welding Co.
Fusion Welding Corporation
General Electric Co.
Hollup Corp.
Igoe Brothers
Koro Corporation
Lincoln Electric Co.
Maurath, Inc.
National Welding Products Corp.
Page Steel & Wire Co.
Quasi-Arc, Incorporated
Reid-Avery Co.
Roebling, John A., Sons Co.
Joseph T. Ryerson & Sons, Inc.
Seneca Wire & Mfg. Co.
Steel Sales Corp.
Standard Steel & Wire Co.
Stoody Company
Taylor-Wharton Iron & Steel Co.
Thomson-Gibb Welding Co.
Welding Service Co.
Wickwire Spencer Steel Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRODE HOLDERS
Allan Mfg. & Welding Co.
Burke Electric Co.
Electric Welding Machine Co.
Fibre-Metal Products Co.
Fusion Welding Corporation
General Electric Co.
Thomson-Gibb Welding Co.
Hobart Bros.
Hollup Corp.
Koro Corporation
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Stoody Co.
Waters Welders, Inc.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRODE TIPS (Resistance Welding)
Elkon, Inc.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
International Oxygen Co.

FACE SHIELDS (Arc Welding)
Allan Mfg. & Welding Co.
Burke Electric Co.
Central Steel & Wire Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
Fusion Welding Corporation
General Electric Co.
Hobart Bros.
Hollup Corporation
Ideal Face Shield Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc, Incorporated
Stoody Company
Joseph T. Ryerson & Sons, Inc.
Sellstrom Mfg. Co.
Thomson-Gibb Welding Co.
Westinghouse Elec. & Mfg. Co.
Waters Welders, Inc.
Williams & Co.
Wilson Welder & Metals Co.
Wilson Products, Inc.

FIREPROOF PLASTIC MATERIAL
Air Reduction Sales Co.
National Carbon Co.

FLANGES, WELDING
Bonney Forge & Tool Works

FLUE WELDERS (Electric)
General Electric Co.
Joseph T. Ryerson & Sons, Inc.

FLUXES
Air Reduction Sales Co.
Anti-Borax Compound Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Kansas City Oxygen Gas Co.
Lotan Research Corp.
Metal & Thermit Corp.
Central Steel & Wire Co.
Modern Engineering Co.
Oxweld Acetylene Co.

EVERYBODY'S BUSINESS

BY FLOYD W. PARSONS

BUSINESS is the oldest of the arts and the newest of the professions. We now understand that executive ability is not merely a gift—it can be developed by careful teaching. Modern executives must now endeavor to shape their actions in accordance with the rules formulated by tradition and the accumulated thought of their predecessors, in very much the same way as do our lawyers, engineers and physicians. They must discard the belief that business is too fluid and fluctuating to lend itself to the collection of permanent facts that will continue to be fundamental.

New Trails in Business

The manager who succeeds today is the one who refuses to accept even the most logical of statements until he is supplied with conclusive facts and figures to support the assertions. This new attitude of reasonable skepticism—being hard-boiled, we call it—is rapidly reducing the percentage of mistakes that are made. It is now necessary to question practically every fact that is presented.

This is particularly true in the matter of so-called "averages." An average figure may be highly deceptive. An average figure on rainfall for the whole United States may be most misleading so far as farmers in Texas or Delaware are concerned. If it is raining in New York and not in Chicago, the New Yorker wants rubbers and an umbrella—not an average.

A little school girl in answer to a question to her teacher once defined an average as "a thing a hen lays on." The answer was prompted by a statement in her arithmetic which read, "a hen lays on an average so many eggs a year." Only too frequently in business an average is likely to be a certain type of abstract something which must be carefully analyzed before it is accepted or used.

Truly, business has become a profession. Ask the able executive today why he favors employee education or the use of better illumination, how he picks his men and pays his workers, or what he thinks of simplification, sales direction, effective price structures, the utilization of waste products and other problems common to his business, and you will get specific answers based on accurate knowledge. Haphazard guessing has no place in the picture.

Light and Profits

Most of our present plans for getting to the truth are highly effective. Research has demonstrated precisely how much it costs modern business to carry on with too little illumination. Recent tests in a number of offices indicated that the average speed of tasks like typewriting from printed copy would be increased 11% by doubling the light, while such work as the transcription of shorthand notes would be speeded up 20%. In most large offices the mere act of supplying more adequate illumination would make it possible to dispense with the services of one or more typists. Concretely stated, the saving resulting from more light in hundreds of places will amount to at least ten times the extra cost for electricity.

Fresh paint will save a vast amount of daylight. A recent exhibit in London consisted of a box, the interior of which was built and fitted to resemble a room in a factory. By turning a lever, paper of a continually darker shade of gray is rolled over the inside walls of this model, to simulate what happens as the fresh white paint on the walls of a factory gets gradually dirty. Although the amount of light supplied by small electric lamps inside the model remains the same, the observer will note that the available light on the workers' benches decreases by more than one-half as the walls are darkened. Dingy paint frequently wastes one-half the light supplied to offices and factories.

Light can do much to increase profits. In stores that are well lighted customers do not return goods so often. "Black streets" are truly back streets in all big cities today. Broadway's activity and fame is due largely to its cataracts of light that blast their way into the spending complex of the bewildered citizen.

A darkened store always creates an unfavorable impression of dinginess, gloom and poor sanitation. Students of illumination recently ran a test in two stores of a totally different character. The study showed that under the old system of lighting less than 17% of the passers-by stopped to look into the window of the first store, which was a retail jewelry establishment. When the lighting system was modernized the percentage of people who stopped jumped to 70. In the case of the second store, which was a restaurant, the advertising value of the brighter windows increased from 21% to 52% by actual count.

The additional amount of electricity cost the jeweler $30 a month, but the result was a growth of 27% in the gross business of the store. The restaurant made a gain nearly as great. Any management that fails to utilize efficient illumination to the fullest possible extent is blind indeed.

Personality in Business

A short time ago a careful survey was made for the purpose of discovering what is meant by a good personality. This study was undertaken because management is always seeking employees possessed of attractive qualities. The outcome of interviews with more than 300 successful business men was the unanimous decision that the three most important personality traits are initiative, integrity and intelligence. Loyalty, appearance, punctuality and other qualities were considered, but it was the common belief of the executives that if a person has initiative, integrity and intelligence, the other desirable characteristics can be developed. This gives business a definite formula to use in picking workers.

Most of the fundamentals of trade and industrial procedure are now clearly outlined. We are busily engaged in wiping out differences of opinion respecting many important questions. Employee education is favored because experience has shown that the only efficient workers are those who like their work, and they cannot like it unless they have been taught to do it well and to understand its purpose.

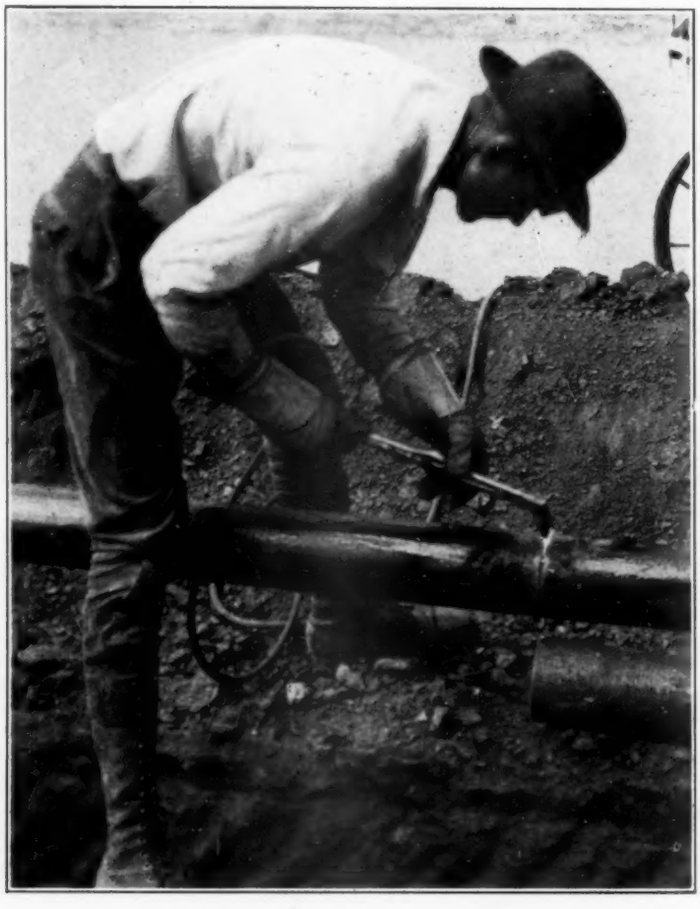
Here are a few other thoughts that have been given wide acceptance: Criticism is necessary to show the individual why and where he is wrong, and how to avoid the same mistakes in the future. But a Simon Legree attitude on the part of the boss breeds resentment and defeats its purpose.

Accurate cost figures are the only sound basis for intelligent planning. The proper use of cost records and stock listings will frequently take the uproar out of a plant and may represent the sole difference between a business that pays and one that does not. It is easy to overload a business with system. A lot of time can be wasted in collecting and segregating sheets of data that are not necessary for an intelligent guidance of operations.

Higher salaries are not a cure-all. Working conditions are quite as important as compensation. Every employer should try to find suitable standards by which to measure the output of workers, and then pay them by results. The mere act of measuring the work of employees will result immediately in an increase in output of 10% or more. When

(Continued on page 51)

"—and the VICTOR attachment cuts up to 8 inches"



This cutting attachment fits the standard VICTOR Welding Torch—It can be attached with the same speed and ease as the welding nozzle—and is as efficient as the standard cutting torch.

Nothing Equals It In Cutting Efficiency

VICTOR
TRADE MARK

VICTOR WELDING EQUIPMENT COMPANY

844 FOLSOM STREET SAN FRANCISCO

EDITORIAL

Artistic Sense in Welded Designs

WITH welding being used more and more in the production of metal furniture, of iron gates, railings, lamps, and andirons, of aluminum household appliances, and of many other things exposed to the gaze of a critical public, no longer does strength remain as the only criterion of good welded construction. The welder himself can put this statement to a test by going in a department or furniture store and making a purchase from a stock of welded lamp brackets. The particular bracket chosen will be selected because of the lines of design or because the sales clerk's powers of suggestion were too strong to be overcome. If the buyer's wife doesn't like the bracket, then the buyer brings his intuition into play, and he may then offer the alibi that it was the only one in the lot having welds with the correct size of reinforcement so it wouldn't shear off when the baby hung from it; for what do women know about strength in design away?

Every welder is a designer to the extent that he alone is responsible for the size of the weld, if not for its final appearance. But the artistic sense of the welder is given its test when, for example, the customer orders an iron railing to replace a wooden one on the porch of his house, without specifying the details of the article. If the welder desires to create a pleasing picture with his welded railing, he first obtains a photograph of his customer's house and of the porch or he visits the place and inspects the house itself. Then he sets about to design a railing that will be in keeping with the general architecture of the house and with the material with which it is faced, keeping in mind that the ornamental angles and curves in the railing must blend with the surroundings or offer a pleasing contrast. If he can distinguish those qualities of the house that are most pleasing to the eye, he may design the porch rail to accentuate them. When the work is done and the neighbors and visitors decide that they want good-looking iron railings on their porches, they turn to the same welder to do the work. The beauty of this welder's handicraft has set it out from the ordinary; hence his reputation spreads and the demand for his skill increases. Today the chief emphasis should be laid on beauty of design of the welded article, even at the risk of slightly increased costs. Those ornamental iron workers who follow this principle will find themselves on the road to increasing business and greater profits.

An Argument for Managerial Understanding

ONE conclusion which can be drawn from the tendency toward including a procedure control in the newer codes which are being prepared to cover the use of welding in important constructions is that these codes point to the necessity of a complete managerial understanding of the welding processes. This point is particularly emphasized by the fact that such procedure controls call for a check on the welders. Immediately, the question is suggested as to who will check the welder. Evidently this must be done by someone having the necessary responsibility and authority. In other words, the management must acquire a thorough knowledge of the subject in order to be able to maintain the control over welding operations which is being specified whenever the work is subject to inspection by insurance companies or regulatory bodies. Plant executives will be benefited, because in addition to safeguarding the efficiency of their welding operations, a better knowledge of the processes involved will enable them to keep the cost of high quality workmanship within the bounds of reasonable economy.

The First Good Results Are the Hardest

WELDING shops who have encountered difficulties of various kinds in attempts to produce welded tanks or other articles from some of the corrosion-resisting steels can console themselves that they are not the only ones who have had trouble. At the same time that pioneer work was being done in the welding of these materials, attempts were being made to produce a satisfactory article by riveting. It might seem at first sight that it would be a very simple matter to set up for riveting these materials in a shop which was completely equipped for riveting ordinary tank steel. However, there have been some very interesting stories told of some of the early experiences in this line. The riveting shops had to work out methods of accurate control for the heating of special rivets required and special methods for driving the rivets. In some cases it was said to have cost quite a lot of money to learn that special equipment and special procedures were necessary. Many welders have felt handicapped in this field because these metals would not weld as readily and with as great satisfaction as they expected. It is not surprising that this should be the case in their preliminary efforts. If the experience teaches them that it pays to proceed with care when welding new materials they will profit by the experience in the long run. The same things which apply to welding and riveting apply to punching and machining and grinding on different materials. The shop which is equipped for handling only low-carbon steel and is not experienced in the handling of various ferrous and non-ferrous alloys may meet with some losses from attempting to work with new materials without finding out whether or not new tools and new methods are necessary. The tools commonly adapted to that type of metal have often proved entirely unsuitable for working on other materials.

Welding Tests Tell Many Stories

THE program of weld testing which has recently been carried on at the University of Wisconsin indicates the need for care in testing welds. It shows that the method of testing must take into account what is expected of the welded structure. A rough summary of some of the conclusions is that the tight welds were not always strong, and the strong welds were not always tight. This would indicate that where both strength and tightness are required, it is advisable to make tests for both of these qualities in the welded structure. An additional lesson learned from this program of tests was the noticeable effect of changing the welding procedure, particularly so when the amount of heat used in welding was varied. This points to the necessity of intelligent supervision and checking during the welding operation. This is undoubtedly desirable whenever the working conditions are such that an individual operator might consider it to his personal advantage to change from standardized welding procedure in this respect. Some very interesting observations were made regarding the ability of experienced welders to judge the strength and quality of welds by their external appearance. In very few cases was it difficult for them to pick out the welds which were obviously defective, but they certainly made a very poor showing in picking out the defective specimens from those which presented a satisfactory external appearance. All of these observations point to the importance of careful selection of welding personnel and of welding equipment, the need for adoption of the correct procedure and of having the operations well enough supervised to make sure that departures from correct procedure will not be allowed.

From a Dime-Sized Button

To

Mammoth Copper Coils

For Better Brazing Results use this Better Brazing Material

HANDY SILVER SOLDERS

12 Standardized Compositions

Cover the Whole Range of Industrial Uses, for joining **all** metals fusing above 1400° F.

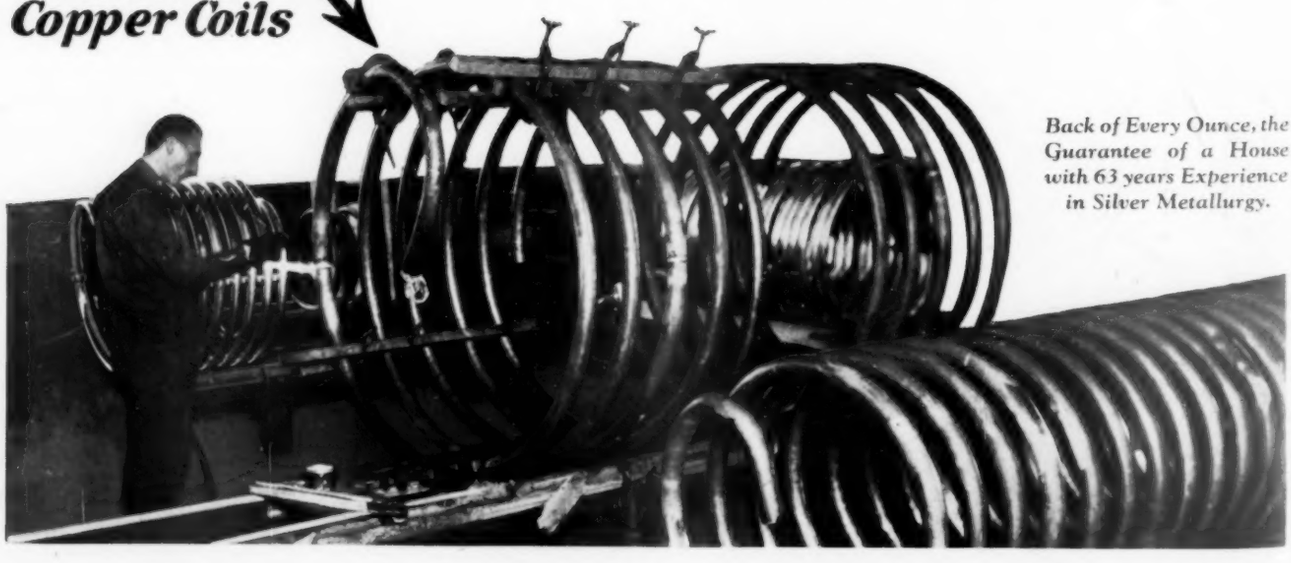
A Formula for each working temperature from 1325 to 1600 deg. Fahr.

Always Dependable
Laboratory-Controlled
Scientifically Safeguarded

Send for our new Bulletin No. 3-W and other useful technical literature.

HANDY & HARMAN

57 William Street
New York



Back of Every Ounce, the Guarantee of a House with 63 years Experience in Silver Metallurgy.

Inspection for Welded Construction*

Proper Inspection Implies a Knowledge of the Factors Involved in Welding Design and Methods, as Well as Alertness to See that the Correct Procedure Is Followed

By John B. Hendrickson†

THE need for competent welding inspection is a very urgent one, particularly if welding is to reach its place in the construction and repair field that many engineers feel that it should. Welding inspection is one of the outstanding things which will contribute to the prevention of failures due to improper welding, which in turn destroys confidence in welding on the part of many engineers both directly and indirectly connected with such failures. It is true that design and method in many cases cause welding failures, but competent inspection can also contribute its part to the elimination of these failures even though it is not essentially a part of inspection to correct design. In the development of any new art there are bound to be mistakes along the way. However these mistakes will not be serious if they are corrected before completion. Final inspection is the last operation, and therefore any mistakes which are passed by the inspector remain in the job.

At present the term welding inspection must be applied to the welding field in a broad sense as it is impossible to have an inspector for every welding job. Therefore, we will consider that welding inspection as far as this paper is concerned may be furnished by the superintendent, the supervisor, the foreman, or by a welding inspector.

The duties and responsibilities of a welding inspector, whether he be superintendent, supervisor, foreman, or inspector, are many, and this paper will cover in detail only the duties and responsibilities of the inspector in connection with metal arc welding.

The first duty of an inspector is to check the functioning of the welding machines on a job whether in the shop or field. He must know whether the welding machines are capable of furnishing the welding operators with the essential welding characteristics which they require. If a welding machine is found defective the person in charge of inspection should see that the machine is repaired by the person or persons whose duty it is to take care of such equipment. Ground connections, cable connections, and cable sizes should be checked, as loose connections or undersized cable all have their part in defective welding.

The welding wire should be checked, first, to conform with specifications if there are specifications covering this; and second, for uniformity and penetration. If the welding wire used is the product of a reputable manufacturer it should not be necessary to check chemical analysis. A few years ago it was very difficult to obtain uniform welding wire. However, today the outstanding manufacturers normally furnish welding wire which is uniformly good. Unfortunately there are times when this is not the case, as a good and uniform welding wire is dependent upon many factors in its manufacture. For this reason it is necessary to check the uniformity of flow and penetration of any welding wire.

The welding operator should now be checked in order that the inspector may know his capabilities. The inspector should be sure that welding operators are capable of making a good weld on any type of work which may be assigned to them. Whenever possible the inspector should make or have made laboratory tests of the welding operators' test pieces. A tensile test will show the relative ability of welding operators. A welder's tensile test pieces, if he is to be used on important work, should show at least an average ultimate strength of over 45,000 lb. per sq. in. and should show not less than 40,000 lb. per sq. in. for his poorest test specimen. If a welder does not come up to these requirements on his first attempt, much discretion should be used before allowing him on important work even though he passes his qualification tests on a later attempt. If overhead welding is required of welders it is well to make all test welds in this position.

Test coupons should be examined by the inspector after fracture for penetration, reinforcement in accordance with specifications, and appearance of the fracture—whether or not it is bright, dense, even textured, fibrous appearing or the weld metal is irregularly torn and free from blow-holes, slag inclusions, overlap and iridescent colors. If the operator is to do all classes of work, the inspector must determine his capabilities in flat, vertical, and overhead welding; also with the various metals which he may be called upon to weld. Of course the majority of welding at present is in connection with mild steel, so this paper will not discuss in detail the welding of alloys or non-ferrous metals.

When the inspector has familiarized himself with the tools for welding—that is, the welding machine, including line cables, the welding wire, and the welding operator—there is no reason why highly satisfactory welding cannot be accomplished provided the inspector is qualified for his position.

The welding inspector should be familiar with the design of the work which is being welded and the reasons for the design. If the design is improper, which unfortunately occurs from time to time with any new art, he should make a written report and suggest corrections. Before critcising any design, the inspector should be absolutely sure that he is in a position to substantiate any criticism which he may make. He should be familiar with residual stress, as this is conducive to weld failure unless properly guarded against.

The inspector should be qualified to read blueprints in order properly to check work. He should also understand specifications, not only in a mechanical way, but should realize why specifications call for doing things a certain way.

Attention to Procedure Control

If procedure control covers the work in hand, the inspector should familiarize himself with the procedure and see that it is carried out. Unfortunately a great deal of welding in the past has been accomplished in a haphazard way. These haphazard methods are fast being eliminated on well-run jobs in both shop and field by the establishment of predetermined procedure. The person responsible for the inspection of any welding work should see that the procedure is properly complied with. In many cases a predetermined procedure is found to be incorrect, and it is changed in the shop or field by necessity. If such changes are made they should be reported in writing to the originators of the procedure in order to prevent the errors from being used on another job where they might not be corrected. There have been many cases where office or engineering instructions covering both design and procedure have been found wanting in the shop or field. In most cases these matters have been corrected in the shop or field; but too often these corrections have not been reported back to the proper persons and the same mistakes have been repeated in many cases, causing defective work and financial loss. The inspector should check the preparation and "set-up" of the work very carefully, as defects in these operations can easily preclude the possibility of a thoroughly satisfactory welding job.

If the tools are right, and by this is meant the machine, the welding wire, and the operator, and if the design, preparation, the "set-up", and procedure are right, the only thing left is the proper carrying out of the welding operation, and this is really a comparatively simple job.

Too many welding jobs are ruined before the actual welding

---

*Paper read at the Fifth Annual Conference on Welding, held at Purdue University, Lafayette, Ind., December 11-13, 1929.

†Mellon, Taylor, Hendrickson, Inc., Philadelphia, Pa.

operation starts by inherent defects in design, preparation, set-up, or procedure. Too often the welding is blamed for failure when the fault really lies somewhere else. By proper forethought in engineering details, by proper supervision and by proper inspection, welding can be made to stand on its own feet. It is not fair to neglect to use sound engineering principles and then blame the welding operation for everything. We must admit that too often in the past the welding operation has been defective, generally due to inexperience or carelessness. However, this is fast being overcome; and if all engineers and those interested in welding will treat welding as a real engineering problem instead of a semi-skilled mechanic's job, as many now do, they will go a long way toward eliminating bad welding and lack of faith, which too often occur in connection with the welding art.

The inspector should know when to use "straight" and when to use "reversed" polarity. He should know proper welding, even though he is not a skilled welder himself. A qualified inspector should check the physical characteristics of welds which are made under his supervison. In metal arc welding, the current, arc voltage, penetration, overlap, appearance of arc, appearance of crater, and appearance of deposited metal are important items to be checked.

The current being used by the operator can be determined by the ammeter. The inspector should be familiar with the proper current, which will vary with the thickness of material, size and type of electrodes, type of joint and preparatory methods.

Technique of the Welding Operation

Under normal circumstances it is well to use the largest-diameter electrode that will give proper welding. It is difficult to set a fixed rule covering the proper diameter of the electrodes, as this varies with conditions. At the present time in manual welding $\frac{5}{32}$-in. and $\frac{3}{16}$-in. diameter electrodes are the sizes generally used. With proper procedure control the size of electrode and the approximate current to be used are specified in detail for each weld. It is the duty of the inspector to see that these conditions are followed as closely as possible.

The arc voltage determines the length of the arc with a given current. In manual welding with bare electrodes up to and including $\frac{3}{16}$-in. diameter, the arc voltage should be approximately 18 and should seldom exceed 20 volts if high-quality welding is to be obtained. A long arc results in improper fusion, improper penetration, and a deposit of inferior oxidized metal. If a short arc not exceeding $\frac{1}{8}$ in. is maintained the resultant oxidization is a minimum. A steady shower of small sparks is shown by a short arc, whereas with a long arc many large globules of metal are scattered adjacent to the weld. A long arc can not only be recognized by the higher voltage but also by its flame.

A short arc with bare or coated electrodes has a subdued crackling or snapping effect which is fairly uniform. If the arc is punctuated by intermittent explosions the arc is normally too long. The creater formed around a short arc is small, and the depth of penetration can be easily checked.

The depth of penetration is dependent upon the length of the arc, the amount of current being used, and the rate of travel or manipulation of the electrode. The depth of penetration should normally not be less than $\frac{1}{16}$ in. when welding mild steel. When welding metal of unequal thicknesses it is possible to secure uniform penetration by playing the arc on the thicker material for a proportionately longer time. The depth of penetration can be checked easily by a capable inspector during the welding operation. It is also possible to determine the depth of penetration to a certain extent by visual inspection of the arc crater and weld.

A welder should leave a crater of sound metal without porosity. This is possible if he is using the proper current and a good welding wire. Inspection of the appearance of the edges of a deposited bead by metal arc welding will show to a great extent the quality of the work. In poor work there is normally an appreciable overlap. This may be caused by the operator, by the welding wire, or by improper current. There is a close contact between the base metal and the edge of the deposited bead in good welding. The angle formed between the edge of the bead and the base metal should always be greater than 90 deg. If this is not the case there is almost bound to be improper fusion and voids between beads.

The appearance of the weld after completion furnishes to the skilled welding inspector a good indication of its quality. The surface of good welds is normally clean and smooth. The surface of poor welds is normally irregular and covered with a heavy coating of oxide. Some welders are inclined to make the surface of their welds smooth by moving their electrode rapidly with a moderately long arc. This should not be permitted and can be readily detected by visual inspection. If the welding is improper the inspector should know how to correct it.

Methods of Testing

The inspector should be familiar with test methods and know how to apply them. At present the main methods of non-destructive testing in use are:

Visual inspection
Hammer testing
Air pressure
Air jet
Hydrostatic, and
Application of benzol or some similar fluid.

These types of testing unfortunately tell only part of the story and do not disclose hidden defects in welds even though the welds may be amply strong to withstand specified tests of the type just mentioned. Non-destructive test methods are being developed which we hope within a short time will make it possible to disclose defects in welds so that engineers will have no hesitancy in using welded designs for practically any class of work where they are applicable. Some of the non-destructive test methods which are now being developed are:

The Sperry electric-current method.
The stethoscope method
The X-ray method, and
The magnetic method.

When one or all of these non-destructive test methods are soundly developed the inspector's job will be much easier.

It may seem as though this paper deals more with supervision of welding than with inspection of welding, but it is felt that the two are closely allied at the present time and will be for some time to come. There are some welding jobs which require inspection only in its strictest sense, but unfortunately at the present time these are in the minority. The use of welding is growing with astounding rapidity, and in the opinion of many it is only in its infancy even now.

One of the largest fields for the application of welding where the surface has merely been scratched is the structural field. To date there have been no weld failures of consequence in this application of welding, although some of you may have in mind one weld which failed in connection with a bridge under test. This failure would have been prevented if competent inspection had caught improper procedure.

If structural welding is to reach its proper place within a reasonable length of time there must be no serious failures, and such failures can be prevented only by proper design and proper execution of the work, together with competent inspection.

It is not obligatory to have special outside inspection, if the welding contractors are properly equipped to take care of their own inspection, and if they are reliable enough not to neglect this all-important phase of the work.

CORRECTION

In the January issue of *The Welding Engineer* there appeared a letter from Captain D. Richardson of London, England, giving a review of welding conditions in the British Isles. In this letter as printed, the membership of the Institution of Welding Engineers was incorrectly given as 143. This was due to an error on the part of the printer. The membership of the Institution is 171.

Welded Steam-Heating Systems*

The Welder Not Only Welds the Pipe, But Bends It to Obtain a Stream-Line Flow, Thus Increasing the Economy of Construction and Operation

By Webster Tallmadge†

TO SPEAK of welded piping today is nothing unusual. Thousands of miles of oil and gas lines at hundreds of pounds pressure are well known. Steam piping, however, presents a somewhat greater problem. It carries a hot expansive and therefore an explosive fluid and is subjected to a combination of stresses of:

1. Pressure of the fluid.
2. Stress due to resistance to expansion of the piping system.
3. Stress due to weight of the piping system.
4. Internal stress in the metal from fabrication.

Combinations of these stresses in couples in high pressure steam piping may easily be sufficient to cause rupture.

The problem therefore requires:

1. Rigid welding procedure specifications.
2. Design of proper supports and anchors to preclude abnormal stresses.
3. Suitable arrangement not only to make the connections but provide the necessary flexibility in the space available.

The following have been used successfully as specifications of procedure.

Welding Procedure

It is the intention of the Engineer that the closest attention be given to the welding operations to the end that satisfactory joints shall be obtained which shall be of full strength and closeness of structure.

Character and Check of Welders

Only competent oxy-acetylene welders having experience in welding wrought iron and steel piping shall be employed.

Any welder considered by the Engineer as not having the skill necessary for the work shall be at once removed by the contractor.

Welding Inspection

The contractor shall at all times keep on the premises during the progress of the work a competent foreman, who shall have sufficient experience with oxy-acetylene welding to enable him to properly interpret and execute the welding specifications.

The Engineer shall have the privilege of having a representative inspect the test of the welders or their work on the line while it is being done.

The contractor shall at the request of the Engineer or his representative, as they may deem it necessary to insure the satisfactory work or skill of the welders, subject any or all welders to a test, or shall remelt a portion of any weld for the purpose of inspecting the quality of the weld metal, or shall remove a small rectangular section of metal across a weld for the purpose of determining the degree of penetration, fusion and density of the welded joint. In the event of these tests of the work showing faulty workmanship, the contractor may be required to remove an 18-inch section of the pipe at the weld for further test to be made by him and to replace such section as shall have been removed.

Test of Welders

The following factors shall be considered in such test and in the work of the welders:

1. A clean welding tip.
2. Soft neutral welding flame, neither pointed nor irregular.
3. Consideration of penetration.
4. "Floating out" of oxides.
5. Even fusion into the base metal.
6. Regular movement of the torch.
7. Occasional check of the neutral flame by throttling back to neutral a momentary excess of acetylene.
8. Uniform incorporation of filler material with the molten puddle.
9. Maintenance of clean, bright red molten metal in the weld puddle.
10. Physical characteristics of weld when pulled in testing machine.

Physical Test of Welding Coupon

Coupons taken from the material welded in the test or from the completed work shall be pulled and the coupons shall closely conform to the dimensions of the American Welding Society specifications for standard tensile coupons for plate steel. Any reinforcement of weld metal on the outside of the joint shall be machined or ground off so that the thickness of the coupons at the weld shall not exceed the thickness of the base metal. The coupons shall either break outside of the weld or have a minimum tensile strength of not less than 50,000 lb. per square inch for any one coupon and an average of 52,000 lb. per square inch for all specimens.

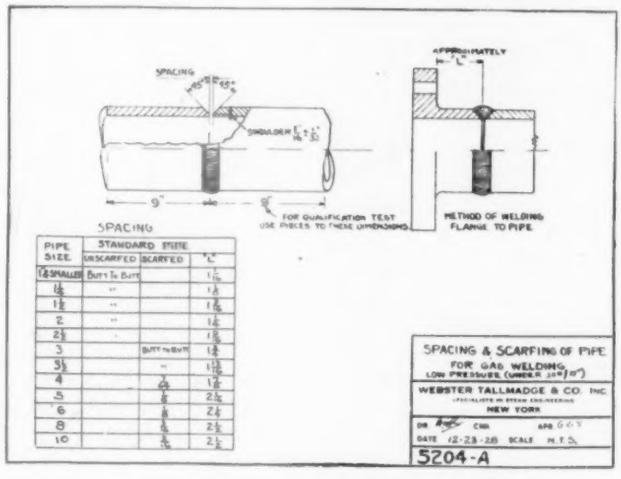


Fig. 1. Details of Welded Pipe Joints.

Welding Apparatus

Welding and cutting torches and regulators manufactured by any reputable concern may be used. They shall at all times be kept clean and in proper condition. Only oxygen and acetylene gases shall be used.

Preparation of Material for Welding

The butts to be welded shall be scarfed or bevelled according to Fig. 1, Dwg. No. 5204-A. Exception will be permitted for making up tie-in joints in which case bevelling may be done with the torch provided the finished bevel conforms closely to the specifications and that all scale and oxide shall be removed from the bevelled edges by means of a hammer, chisel, or file.

Butt welds shall be a width of not less than 2½ times the pipe wall thickness, a penetration to the inside wall of the pipe or to the bottom of the vee, and a reinforcement in the finished side of

*Paper read before the 30th International Acetylene Association Convention, Congress Hotel, Chicago, November 15th, 1929.

†President, Webster Tallmadge & Co., New York, N. Y.

not less than 25 per cent of the pipe wall thickness. There shall be no valley at the edges of the joint and the weld shall be built up so that the weld metal shall present a gradual increase in thickness from the surface of the pipe to the center of the weld.

The pipe surface to be welded shall be free from all scale, oxide, or other foreign material. The joints shall be carefully aligned, spaced and tacked (temporary weld for alignment) at a sufficient number of places to secure and maintain their alignment. Clamps may be used to facilitate the lining up and tacking of the pipe sections. No pipe shall be erected in such a manner as to prevent the easy manipulation of a welding torch or rod while making the tie-in or position welds.

Proper allowance for contraction due to welding shall be made in setting up pipe that must make up exact dimensions. Pipe other than bends shall not be sprung into position. Where undue strain is required to join the piping, the pipe on either side of such point shall be properly adjusted by the aid of heat under proper supervision or, at the discretion of the Engineer, or his representative, be reconstructed.

Welding Technique

These specifications do not attempt to restrict the welders to any one method of manual production of weld metal, the gas pressure used during welding, or the manner in which they apply themselves.

So-called ripple welding is not essential. A flat finished reinforcement is equally as good. Care must be exercised to fully fuse the base metal with the deposited metal. A penetration of the weld metal to the inside wall of the pipe is essential for all joints. Care must, however, be exercised to prevent the occurrence of protruded weld metal into the pipe which restricts flow. The weld shall be of sound metal, free from laps, cold shuts, gas pockets, oxide inclusions and similar defects. The backhand method of welding and continuity of deposition are recommended for butt welds. This, of course, applies to rotative welds mainly but should be observed for position welds where practical.

Where rotation is possible, a continuous weld shall be made as the pipe is turned. On horizontal piping, if position welds are required, the welder must start at the bottom of the pipe and after completing one-half of the joint start from the original point and continue up the opposite side until the seam is completed. All tack welds shall be melted out as the welding progresses, and incorporated in the joint.

If the welding has to be stopped for any reason, the operator on restarting shall reheat the weld for an overlapping distance of two inches and shall remelt and reweld into the previously welded portion for a distance of about a half-inch or until solid metal is exposed. Where the weld ties into a previously welded portion, the operator shall observe the same requirements as given above for starting incompleted welds.

At the point where the weld begins and ends particular care must be exercised to insure against a porous crater to permit leakage.

All pipes 1½ inch and less to be bent by first heating with torch. In pipes 2 inches and larger where torch bending is impossible a "Tube Turn" must be welded in.

Welded steam piping may be divided into three classes:

1. High Pressure Power Plant.
2. High Pressure Underground.
3. Low Pressure Heating.

High pressure power plant piping has been gas welded for twenty years and when properly done under good welding procedure specifications, it is beyond comparison for low amortization, low maintenance and low first cost. The marked absence of leaks from reduced number of packed joints lengthens the life. A leak erodes away the metal of the joint flange face or thread, making it impossible to be kept tight.

Some welded joints have failed from poor workmanship by unskilled men or from internal fabrication stress plus external strain or in some cases due to the parts not having been annealed. It is sometimes necessary to anneal welds on massive work on pipe six inches and larger subjected to unusual pressure or unusual external strain by means of a portable furnace around the weld. In emergency cases we have set up improvised furnaces in the form of a loose dry fire brick box around the pipe heated with either a coke, oil or gas fire to a cherry red and reducing the heat slowly. The most important thing in the writer's opinion is to avoid rigidity in laying out the design by avoiding anchors and by using in their place long flexible hangers such as chain, free to move in all directions and with springs compressed initially to three times the pipe movement wherever vertical expansion is encountered. These are called "floating piping systems." An unusual movement in any portion distributes the strain through the piping system instead of concentrating it.

Every possible joint and gasket should be avoided. The Sargol joint is universally used in all modern high pressure piping. It is a flanged joint of the Van Stone type in which the flanges are

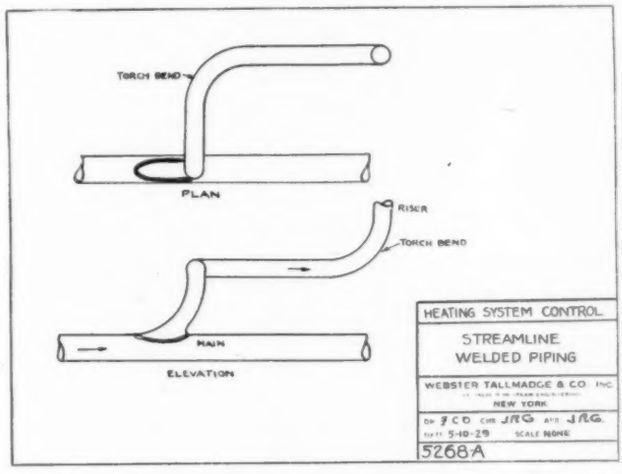


Fig. 2. The Pipe Is Heated and Bent in Easy Curves to Reduce Resistance to Flow.

loose forged steel rings drilled for the bolts. They are placed loosely on the pipe, the ends of the pipe are then heated and a short radial lip is rolled or pressed on each end. The faces of the lips are then machined true and the periphery chamfered or bevelled to form an apex to be fused or a crater groove to be filled with a welding torch as a seal, instead of a gasket. The crater type is preferred by many as it can be easily separated by a chipping hammer and reused. This is, however, optional as it is seldom necessary.

There is another class of steam piping for underground transmission.

Welding District Heating Supply Mains

This is an era of Public Utilities. From the time that Alexander Hamilton organized the Society for the Establishment of Useful Manufactures at the Passaic Falls Power Development to supply power to mills, declaring to the world by demonstration that the new baby nation was industrially independent and around which has grown the "Silk City," Paterson, our utilities to serve the public have become our greatest business.

Financial men seek more public utility companies to buy and sell as the older companies are absorbed by the holding trusts. Electric, water, gas and telephones are massive coordinated combinations with few independents but District Steam Companies have lagged. New York, Pittsburgh, Detroit, Rochester, Chicago, and St. Louis are served by successful strong companies furnishing steam for building heating process and occasionally for power. Boston is now greatly enlarging its plant and extending its service.

Many buildings are being constructed in these cities without coal bunkers, boilers, or chimneys or even provision for them.

District steam heating was invented in 1877 by Birdsell Holley in Lockport, N. Y. In the early days, district heating with steam at pressures above a few pounds was in general unsuccessful.

Many companies failed and a number were discontinued. Expansion, leaks, heat insulation and drainage were all very serious obstacles. It was difficult to construct a substantial job and make sufficient revenue for operating, to say nothing of dividends.

High pressure underground piping today is commonplace and if not welded is inexcusable. This is a case where anchors are absolutely essential and must be rigid, for at street crossings, branch pipes must not move laterally and long runs through streets must not move too far longitudinally or the customers' service pipes will be sprung and ruptured. Bends cannot be used to absorb expansion, for space below the streets is limited by already existing sewer, water and gas pipes, telephone and electric conduits and surface car roadbeds. Subterranean rock is frequently encountered, complicating the problem of finding space for the steam pipe and its insulation, to say nothing of finding space for bends. The packless expansion joint with welded ends is a satisfactory solution. Frequent anchored points with these expansion joints midway between them so that the maximum pipe movement is but a few inches, is a satisfactory solution.

In constructing systems of this kind, economical production can be obtained by setting up a welding station at a central point. Join several lengths into a unit and snake it to its destination by tractor, roll it into the ditch on to the drainage bed of crushed stone and tile, weld on the expansion joints, insulate and cover with the protecting armor, back fill and pave the street with the idea of not seeing it again, is regular practice.

In these kinds of systems the streets are not being torn up for repair of steam leaks. There are now many such installations but we have not scratched the surface, and district heating, the biggest field for public utility development, lies practically dormant. This statement is based on experience in financing, design, construction and operation. The strange thing about it is that the operating revenue is such that the dividends on a well operated system are larger than for electric service in many cases. Many

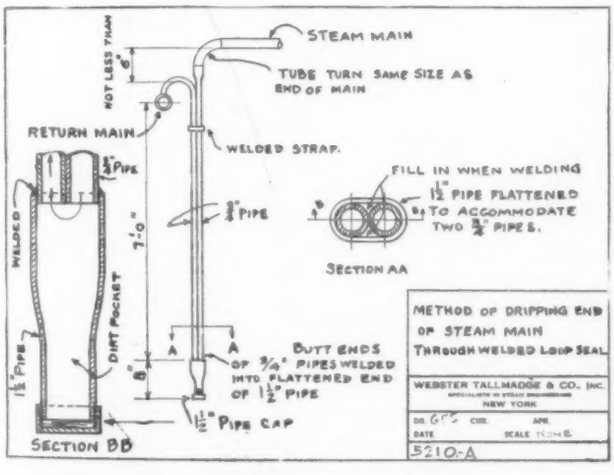


Fig. 3. Method of Fabricating a Welded Drip Pocket.

systems transmit steam two miles from the central boiler plant with but small loss, affording opportunity for large production at lower costs.

"Stream-Line" Systems

A new field is opening for the oxy-acetylene welder that has no competition. It is the high efficiency "stream line" heating systems for buildings.

Steam has been increasingly used for heating buildings for the past fifty years and but little had been accomplished until a few years ago in designing heating systems for an economical balance in operation. The radiators were either fully heated to the thermostatic trap on the return outlet or were completely shut off. No means was provided for using a small amount of steam on mild days or admitting more steam to the shady and windy sides and less to the protected and sunny sides. Even greater refinements are pratical. It hardly seems reasonable that such a matter of fact self-evident condition with millions of buildings and thousands of technical engineers working on the designs, that more has not been done. The reason is apparently a simple one of diverted drift in the commercial practice from the basic logic often encountered in everyday life.

Consider the technique for a minute. The wind and sun are not effective in warming or cooling all sides of the building simultaneously. It is, therefore, evident that the same quantity of heat is not required on all sides of a building at the same time. In the ordinary heating system the resistance of the pipe against the flow of steam is greater to the far away radiators than to the nearby ones. If the supply of steam is reduced due to moderation in the weather, then the nearby radiators get all of the reduced supply and are heated fully, but the far away radiators get none. Thomas Edison overcame a similar condition in the electric light circuit by making the resistance of the lamps themselves as much as a hundred times the resistance of the wires so that the resistance of the wires carrying the current was inappreciable. He used different material to alter the resistance to flow, such as copper and silver for low resistance and carbon, iron and German silver for high resistance.

In piping, the area of the passage, amount of turbulence, swiftness of current and distance affect the resistance to the steam flow. Rough interior surfaces of the metal, sharp turns, and abrupt variation in the area cause turbulence or eddies and the steam is compelled to push itself out of its own way as it flows along. Small pipe sizes and long runs with increased velocities and prolonged surfaces to pass over cause increased resistance.

The distribution problem is solved by two methods:

a. Increasing the resistance of the radiator.

b. Reducing the resistance of the pipe.

The increased resistance of the radiator is accomplished by use of orifices in the radiator inlet.

By making the orifice in practical sizes and on a scientific basis, many ordinary heating systems have been perfected so as to use much less steam and fuel and give far better comfort from reduced overheating.

The reduced piping resistance was brought about by a method of torch bending the piping into shape on the job as the heating piping system is fabricated. Joining the "run out" pipe supplying a radiator to its riser by welding an easy lateral branch and torch bending the pipes in gradual easy curves (Fig. 2, Dwg. 5268-A), the resistance to the flow is little more than the resistance of the corresponding straight pipe before bending.

In modern designs, a separate supply main and control valve is installed for each side of the building and is known as zoning. Connecting this supply pipe to the center of the main so that the steam flows shorter distances, accomplishes both flexibility for adjustment of the quantity of steam supply to the demand and greatly reduces the piping resistance.

Control of the steam supply is accurately accomplished by a simple electrical driven device attached to the control valve. That part, however, is a thermo-dynamic problem and is out of place in this paper.

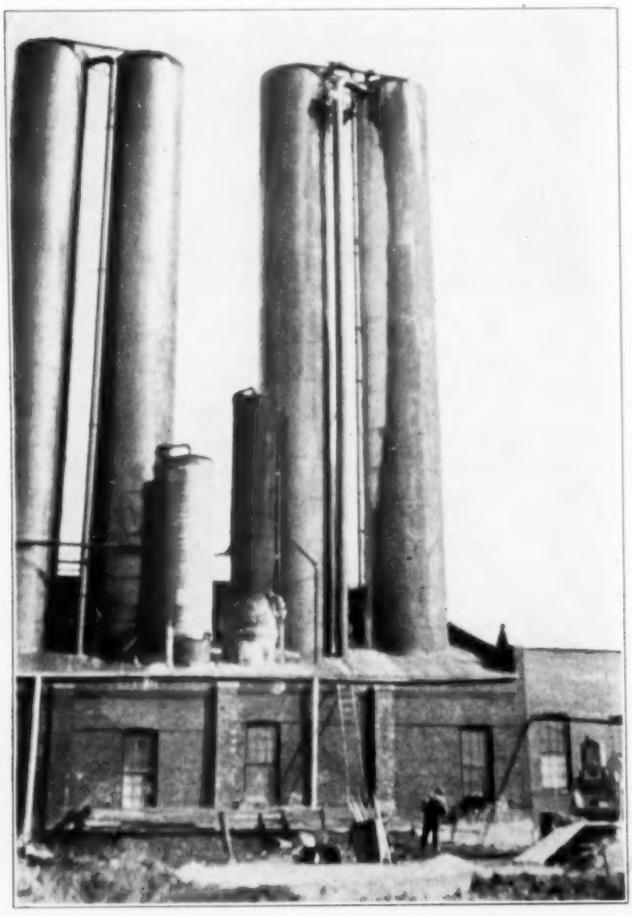
We have now planned one more step forward—the design of a heating system in which the radiators rise and fall with the piping movement as it expands and contracts.

Heating systems of the latest design use just half of the steam compared with the old style, do not cost appreciably more and in large buildings can be designed to cost less than the ordinary system. The comfort and health of the occupant is far better for many so-called ventilation problems are simply overheating.

The heating engineers are by these means enabled to design heating systems with piping sizes laid out on a scientific basis. It will, of course, be years before it is universally the practice, but the results are so glaring in contrast with the old system of screwed cast iron fittings and pipe nipples that progressive engineers, building owners, and operators are demanding the better systems and the stream line high efficiency heating system which has smaller pipes, fewer devices, better economy and better comfort is the solution.

WELDING MAKES TIGHT PIPE JOB IN DRY-ICE PLANT

When a long vertical run of pipe was recently installed connecting the top of a 100-ft. tower with the bottom of another and similar tower at the plant of The Liquid Carbonic Co. at 3100 S. Kedzie St., Chicago, welding was resorted to in order to obtain tight joints. The old pipe, which the welded pipe replaced, was fabricated in this plant and was of riveted construction. Trouble was had with the gas blowing through the leaky seams in the old pipe and impinging on the towers located on each side of the pipe. The illustration shows large areas on both towers where the paint had been removed by the harmful effect of lye



Welded Pipe Is Seen Between the Two Towers in Center of Picture. Arc Welder Is Working on Pipe Elbow 100 Ft. in the Air.

in the leaking gas. The frequent repainting of these towers was a heavy expense.

The new installation is gas-tight and is constructed of 18-in. 9-gage pipe with an all-welded elbow at the top. Three 40-ft. sections of pipe were used, each section being comprised of seven short lengths, and these sections were cut and erected to fit the requirements of the job. The complete welded installation was made by the Western Welding & Equipment Co., of Chicago.

This pipe carries gaseous carbon dioxide at a pressure of about 15 lb. per sq. in., which gas is later liquefied and then solidified, in which state it is known as "dry ice" and has a theoretical temperature of 162.5 deg. F. below zero, its chief use being as a refrigerant in the transportation of perishable foodstuffs.

The carbon dioxide is generated by burning coke under a steam boiler, which is located in one end of the building shown. This boiler has no chimney; instead the products of combustion, composed chiefly of carbon-dioxide gas, are lead through a washer to extract the sulphur compounds and other harmful gases and solids, and then they pass up through one of the large towers shown, then down the welded pipe, and then up through the other tower. The plant also contains another pair of towers similar to these, which were maintained in operation while the piping installation just described was being made.

These towers are filled with coke, into the top of which is sprayed a lye solution which trickles downward and dissolves the carbon dioxide in the up-flowing gas. The gas, as it flows through the welded connecting pipe, carries with it some of the lye in suspension; hence it has a deleterious effect should it blow through the pipe seams and impinge on the towers.

The lye solution is then heated, which frees the disolved carbon-dioxide gas; and this gas is then compressed, then cooled, and finally expanded, resulting in a very low temperature, which turns some of it into snow. The snow is compressed at 40 tons pressure in a hydraulic press, forming 10-in. cubes of "dry ice."

TRUST COMPANY ADDS WELDED STORY TO ITS PRESENT BUILDING

A new story is being added to the Union Trust Company Building in Cleveland, Ohio, by arc-welded construction, without the usual distracting noise of riveting. The occupants of this and adjoining buildings, because of the total absence of the sharp staccato din of the riveter's hammers, would not know that a story was being added except for the visual evidence. The new story will house the Cleveland Stock Exchange.

The Board of Directors of the Union Trust Co., in specifying welded construction for the new story, profited from the experience of the Irving Trust Co. of New York, who sent engraved notes of apology to more than 500 neighbors when they let the contract for the erection of a 54-story building on Broadway and Wall St. Mr. Wart, president of the Irving Trust Co., asked his neighbors' indulgence "during the unavoidable noisy weeks that lie just ahead" while the steel frame of the building was being erected.

The addition on the top of the Cleveland building is 52 ft. square. The steel frame was erected by extending the present columns, except in the case of the outside bay, where it was found more convenient to set the columns in on the existing beams, which were strengthened by welding under them a 24-in. I-beam extending between the vertical columns.

The steel in this addition was erected by the Republic Structural Steel Works and the welding current was furnished by Lincoln "Stable-Arc" welders.

CHICAGO A. W. S. MEETING DEVOTED TO COPPER WELDING

The various factors influencing the success of copper welding were clearly outlined by S. J. Mashl, of the Van Schaack Chemical Works, Chicago, in a talk before the Chicago Section of the American Welding Society on the evening of March 6th. The meeting was held at the Greer School of Automotive Engineering, 2024 S. Wabash Ave. The speaker described, and illustrated by lantern slides, some of the types of equipment made and used in the Van Schaack plant, and discussed the advantages of welding in the fabrication of this equipment. Information was given on the preheating of copper before and during welding, types of welding wire used (both arc and gas), technique employed, and the degree of success obtained with the welding of different grades of copper. A general discussion followed the lecture.

A demonstration was held in the welding class room of the Greer school, in which Mr. Mashl butt welded two dished heads onto a copper cylinder, forming a test tank, which was then subjected to 1,000-lb. internal hydraulic pressure, but no sign of rupture occurred.

Repairing and Rebuilding Mill Motors

When Bearings Are to Be Changed or a Brake to Be Added, the Motor Frame Is Not Scrapped But Welding Is Resorted To

By J. L. Brown*

ONE of the greatest forward movements of the last few years in the design of machinery and building structures is the adoption of the metallic arc-welding process as a major element in manufacture. Many machine parts, formerly appearing as castings, may now be fabricated out of rolled structural steel shapes cut to form by the oxy-acetylene flame and the abutting edges joined by fusion with the molten deposit from the steel welding wire. Also, in structures such as factory and office buildings, where rolled steel shapes have, for many years, been the accepted standard, the metallic arc has begun to displace the time-honored rivet on the intensely practical basis of joint efficiency as regards both strength and cost.

In the wave of popularity of the new method as a means of producing new machines and structures, there is danger of losing sight of its very practical efficiency in restoring old parts to usefulness or modifying them to serve a somewhat different purpose from that contemplated in the original design. Cast steel parts particularly lend themselves readily to repair and modification by the metallic arc process; and although satisfactory welding of cast iron is not so readily accomplished as welding of steel, many cast-iron parts very expensive to replace may be restored to service after a skillful repair weld has been made. Some examples of the great utility of welding in making repairs and modifications to cast steel mill-motor frames are illustrated and described in the following paragraphs.

In spite of the heavy clamping pressure used in securing mill-motor bearings in their housings (which are extensions of the upper and lower halves of the frame itself), the rugged service to which these motors are subjected results in some cases, after some years of service, in a certain amount of wear not only of the bearings where they fit in the frame but of the corresponding supporting webs of the steel housings. Were it impossible to add metal to these bearing seats, it would be necessary either to scrap the whole frame or bore the bearing seats to a larger diameter, and make up special bearings to suit the increased bore. This procedure is, however, very undesirable from the standpoint of interchangeability, and it is preferable to lay down a layer of welding material over the worn surfaces and bore out to the correct diameter.

Fig. 1. Motor Bearing Seats Built Up by Welding.

Fig. 1 shows the bearing seats in one of the frames welded preparatory to reboring.

Fig. 2 illustrates a method of modifying an existing steel mill-motor frame to permit mounting of a brake in a special case where floor mounting of the brake was not feasible. The contour of the frame prior to the modification is obviously not well adapted to attaching a brake mechanism, and yet by the simple metallic arc process, a few small blocks of steel may be readily attached to the existing frame in such a way as to provide an ideal mounting for a brake. Indeed, it would be difficult to provide a more suitable mounting had necessity for brake mounting been contemplated in the original design, and the mounting lugs, therefore, cast integral with the motor frame.

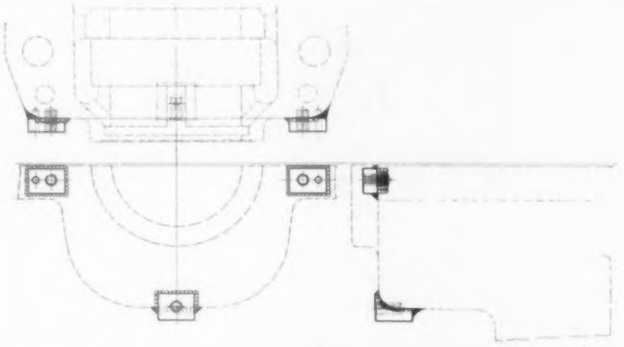


Fig. 2. Scheme of Welding Lugs on a Motor Frame to Permit Attaching Brake Mechanism.

A quite interesting and considerably more elaborate modification of these mill-motor frames, accomplished largely by arc welding, has in some cases been undertaken in avoiding departure from standardized roller-bearing sizes in bearing change-overs.

Some attempts, more or less successful, have been made to apply roller bearings to existing mill motors without recourse to welding and oxy-acetylene cutting, resulting in the use of bearings other than the 300 series adopted as standard by the agreement between the Association of Iron and Steel Electrical Engineers and the roller-bearing manufacturers. This standardization, intended to apply primarily to future motor designs, has the obvious advantages of interchangeability as between various makes of roller bearings, simplification of manufacture, and reduction in the number of spare parts; but its greatest efficiency cannot be realized unless it can be made to apply to existing designs and to bearing change-overs in existing motors. The following paragraphs with accompanying cuts show clearly and in detail how this may be accomplished with the minimum of effort when for any reason a bearing change-over may seem desirable.

Reference to Fig. 3 will make clear each step in the modification. This shows a standard mill-motor frame of average size opened to display the interior form of the bearing housings. By comparing the left center view with the upper one, it will be seen that the central support or web has been cut away from each of the four half housings. The cutting out of this web, which is used in the sleeve-bearing design to support the inner end of the bearing, was accomplished by use of the oxy-acetylene flame. The total cutting time per frame to remove the webs and other irregular projections which might interfere with the roller-bearing cartridge

*Industrial Motor Engineering Department, Westinghouse Electric & Manufacturing Co.

was 2½ hr. The necessary welding additions to the housings were made in the total time of 14 hr. The frame interior with welding additions in place is illustrated in the right center view. The comparatively thin inside web of the housing has been built up to form a substantial support for the inner end of the roller-bearing cartridge.

After the final machining, which occupied a total time of three hours, the interior of the frame presented an appearance as in the lower view of Fig. 3, permitting assembly of the roller-bearing cartridges as they appear in the complete motor assembly illustrated in Fig. 4.

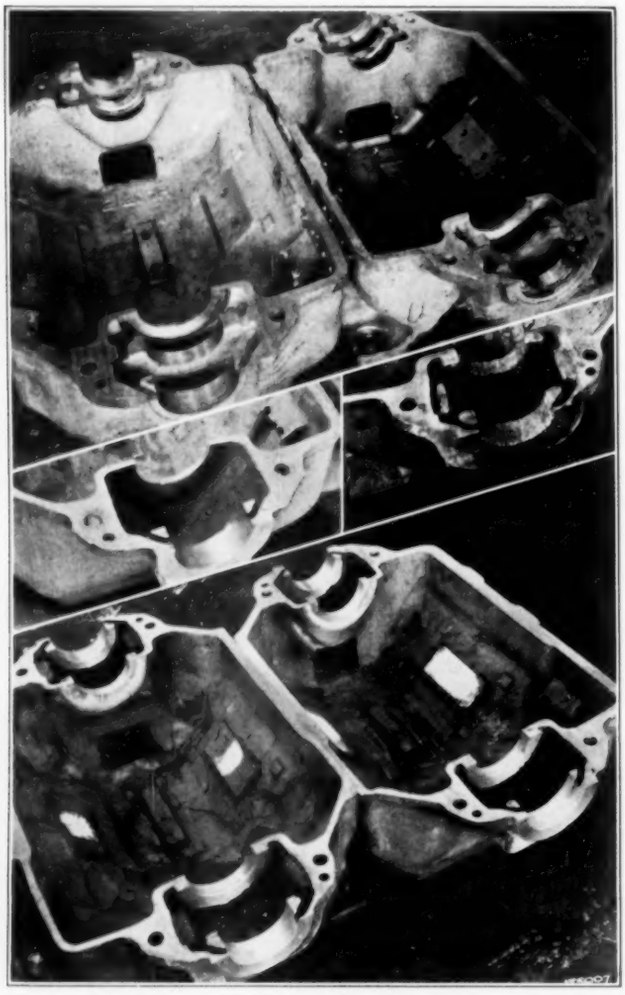


Fig. 3. The Central Webs of the Half Housings (Top) Have Been Cut Away by the Torch and the Two Remaining Supports Built Up (Center). The Completed Bearings Are Shown Below.

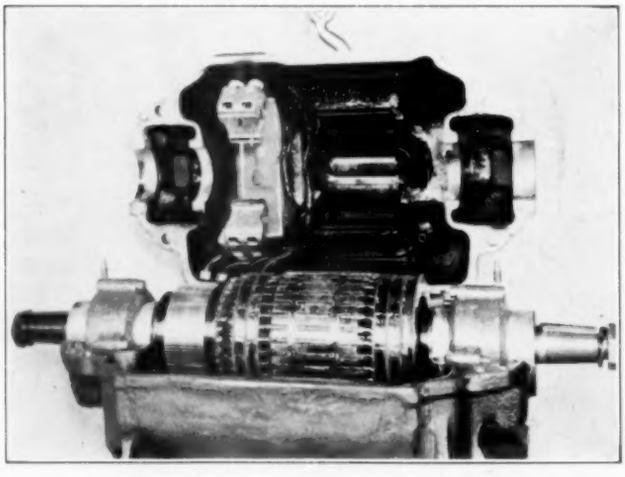


Fig. 4. Complete Motor Assembly, Showing Roller Bearing Cartridges.

Only a few years ago the modifications described and illustrated here would have seemed very difficult, but with the rapid development that has taken place in recent years in steel fabrication by the electric arc and oxy-acetylene flame, the necessary modification becomes only an average job when adequate working drawings are available.

SHIP TANK TOPS TO BE CONSTRUCTED BY ARC WELDING

Work is now going forward on the construction of new tank tops for the steamers *Charles O. Jenkins* and *Ispheming*, the former being done at Huron, Ohio, by the Cleveland Stevedore Co., and the latter by the Great Lakes Engineering Co., at River Rouge, Mich.

The present tank tops in these vessels are of the usual plate construction fabricated by riveting. Several methods of burning out the rivets in the old tank tops have been tried, the most successful being the carbon process. The rivet heads are quickly cut by the carbon arc to such an extent that the rivets may easily be driven out by air hammers. To facilitate removal of the tank tops from the hold, the plates are cut into sections by the carbon arc.

The new tank tops will be of channel-steel construction, completely fabricated in the cargo hold by arc welding, thus eliminating all shop fabrication. This will be the first time that arc-welded construction has been used in modern tank tops on Great Lakes vessels.

The channel-steel system of riveted construction was first used in the retanking last year of the steamers *Colonel* and *Grand Island*, which are owned by the Cleveland Cliffs Steamship Co. It was through these initial installations, which proved to be most successful, that a step further has been taken in going to welded construction, to make a stronger, more economical, and all-around better job.

The channels being used in the construction of these new tank tops are 12-in., 37-lb. ship channels, with ⅝-in. web thickness. This heavier web thickness increases the weight to 38.1 lbs. per lineal foot. The channels which are 48 ft. long, are set up in sections in the cargo holds, each section comprising 10 channels. All the channels are joined to each other by the "Electronic Tornado" process of automatic carbon-arc welding, by which the metal in the heels and in the toes of the flanges of adjacent channels will be fused into each other without the use of additional metal. Thus each section of the tank top will be literally one solid piece of rolled steel. The sections are then arc welded to each other in place to form the complete tank top, which likewise will then be one piece of steel.

There will be approximately 48,600 lineal feet of welding in the *Charles O. Jenkins* and 38,700 lineal feet of welding in the *Ispheming*. "Stable-Arc" welders and "Electronic Tornado" automatic tractor-type welders, manufactured by The Lincoln Electric Co., Cleveland, Ohio, will be utilized in this work, as well as in the construction of a new channel-steel bilge ceiling for the *Presque Isle*. The old lower strake of the side tank plating on the *Charles O. Jenkins* will also be replaced by arc-welded channel-steel construction.

The advantages of the channel system of construction, fabricated by arc welding, over the traditional riveted plate construction are a stronger and more rigid tank top with practically no increase in weight, and a reduction in construction costs. The additional stiffness results from the flanges of the channels acting as continuous stiffeners, and their closer spacing.

For intermediate floors, the channel tank top requires only half the number of stiffeners as in the plate tank top, because the flanges of the former have enough strength to permit a wider floor spacing. Maintenance costs are reduced and the life of the tank top is increased due to elimination of rivets, which often work loose and whose heads become badly worn due to abrasive action of buckets and cargo; also because the channel tank top has practically double the strength against buckling as has the plate tank top.

Preheating Principles and Practice*

Correct Preheating Practices Require a Knowledge of Heat Conduction in Metal and Expansion and Contraction Stresses

THE fact that all metals expand when heated and contract upon cooling is well understood. When the oxy-acetylene flame is applied to metal, thus raising the temperature greatly at the heated point, the heat spreads through the adjacent metal, which consequently is expanded. When welding is completed, the heat is radiated from the section around the weld and this cooling section contracts. Ductile metals, such as steel, seldom suffer serious internal strain during this expansion and contraction, but non-ductile metals and metals which are comparatively brittle may develop strains which may cause distortion or possibly fracture.

All welders know that the net result of this heating and cooling is determined largely by the shape, size, and design of the part being welded. In welding together the pieces of a broken straight bar, for example, the effect of heating and cooling will not cause any difficulty because the bar is entirely free to expand and contract. Very few of the parts that require the welder's attention are as simple as this, however. The welder is constantly called upon to repair broken parts of irregular shape and intricate design or to make welds to join sections quite different in thickness. All such work and, in fact, practically every job that a welder undertakes requires a thorough, practical knowledge of the effects of expansion and contraction.

Provision for the relief of contraction stresses is particularly important where welds are made in parts that are confined at each end, as the spokes of a wheel or pulley. Unless

Fig. 1 (Below). Permanent Preheating Furnace Designed for Steady Work.

Fig. 2 (Above). Gas-Fired Temporary Preheating Furnace.

proper precautions are taken, the contraction stresses set up by the cooling weld may be great enough to fracture the spoke.

Intelligent application of preheating affords the most satisfactory method for relieving or avoiding expansion and contraction stresses.

By proper heating, a body expands in all directions, and the heat of welding becomes a minor force. When allowed to cool slowly either in a furance or in an annealing bin, the contraction will also be in all directions and there will be no resulting stress.

Preheating may also be necessary or advisable for other reasons. The time required for welding a hot piece of metal is considerably less than that required if the metal is cold and has to be brought up to the welding temperature of the oxy-acetylene flame alone. A considerable saving in oxygen, acetylene and time can therefore be effected by the preheating of the metal with a cheaper fuel. With certain metals, notably cast iron, a weld made on metal properly preheated and slowly cooled can easily be machined, whereas a weld which has been made on cold metal and cooled suddenly afterwards will be hard and brittle and very difficult to machine. Proper preheating and subsequent annealing have the additional advantage of relieving strains which may have been in the casting ever since it left the foundry.

Various types of apparatus and agencies are employed for preheating, depending, of course, upon whether the preheating

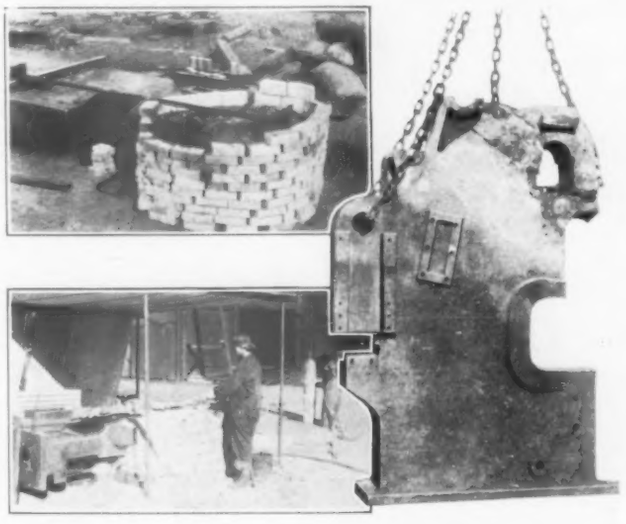


Fig. 3 (Top). Side Frame of Shear Prepared for Preheating.
Fig. 4 (Bottom). Shear Frame Being Welded Inside the Furnace.
Fig. 5 (Right). View of Frame After Welding With Cast-Iron Rod.

is to be general or purely local. The simplest form of local preheating is that which is accomplished by the oxy-acetylene blowpipe flame itself. If the part to be welded is small and the ends free to expand and contract, it is only necessary for the welder to play the blowpipe flame over the metal around the part to be welded before the actual welding is done.

If a forge fire is available, it provides a very convenient means of preheating metal. Care must be taken, however, that the blower is used only enough to keep the fire going and that too much heat is not applied to the metal. Use of an asbsetos paper covering is advisable to protect the metal from any possible drafts.

Many types of preheating torches are available which burn inexpensive fuels such as kerosene, fuel oil, natural gas, or city gas. These may be used to accomplish local preheating on large pieces of metal, and, if used in a furnace so that they do not play directly upon the metal, they may be used for general preheating.

For general preheating where many similar large castings are to be welded special permanent preheating furnaces are employed. Preheating furnaces of this type are usually fired with either natural or city gas, as the gas flame is so easily controlled. Fig. 1 shows a permanent preheating furnace used for preheating a regular run of cast iron, steel, and aluminum castings. This type of furnace is also used in the preheating of pipe for bending. The heat may be directed

*Reprinted from Oxy-Acetylene Tips, issue of March, 1930.

right onto the metal or the preheating may be done indirectly.

The most common preheating agency for general preheating is the temporary fire brick furnace, fired with charcoal. Charcoal is a most effective preheating fuel as it requires no forced draft to burn and its combustion will give a steady, constant temperature. No soot or smoke is given out, which might deposit on the metal and hinder the welding operation. Temporary fire brick furnaces are sometimes fired with gas, oil, or kerosene preheating torches instead of the charcoal. Coke should not be used as a fuel, as it gives too high a temperature and too localized a heat.

The temporary brick furnace is constructed by laying the bricks up around the casting, allowing enough space between the brick wall and the casting for the fuel and to permit handling the casting if turning is necessary during welding. The lower tiers of the brick are set with air spaces between them so that the right amount of air may get into the furnace to insure the proper combustion of the fuel. Fig. 2 shows a temporary brick preheating furnace built around a rotary pump casting in a chemical plant. The design of a temporary furnace will vary with each piece to be preheated, depending upon the size, thickness and type of metal. For instance, with very large and heavy castings it may occasionally be necessary to use more than one thickness of brick in making the wall of the furnace. The most usual covering for a

Fig. 6 (Left). Small Parts Locally Preheated With Blowpipe.
Fig. 7 (Right). Preheating a Punch Press in a Temporary Furnace.

temporary brick preheating furnace is a sheet of asbestos paper supported on bars or light angle iron placed across the top of the furnace. Several small holes are punched in the paper to allow for the escape of the products of combustion. The section of the metal to be welded should be near the top of the preheating furnace, so that when the proper temperature has been reached in the preheating the asbestos paper covering may be drawn back sufficiently to permit the welding to be carried on while the metal remains within the furnace. After the weld is finished, the whole furnace is recovered to protect the metal from sudden cooling.

Cast Iron

The most commonly used metal which requires preheating before welding is cast iron. The physical properties and the methods of treating this metal should therefore be considered first in any discussion of the subject of preheating.

In ordinary gray iron castings, free carbon is present in the form of graphite flakes. This graphitic carbon gives gray cast iron its characteristic properties such as machineability and is also partly responsible for its susceptibility to fracture under sudden shock. The whole theory of successful cast iron welding is based upon retaining the gray iron structure in the finished weld. Cast iron welding rod of high silicon and adequate carbon content is of paramount importance in securing this. Proper preheating and annealing are also vital. When gray iron is melted the graphite flakes dissolve. If the molten iron is cooled quickly the carbon does not separate out again as graphite flakes and the result is hard, unmachineable white cast iron. The slow cooling or annealing necessary for the formation of graphite is facilitated by proper preheating prior to welding. Preheating of gray iron castings is also essential in order to avoid expansion and contraction strains as noted previously.

In using cast iron welding rod for cast iron welding, the whole casting must be preheated in a furnace, or a sufficiently large section of the casting must be preheated locally. A large cast iron side frame of a shear is shown in Fig. 3 with the broken end enclosed in a temporary furnace. A charcoal fire brought this section up to the proper temperature so that it could be welded with cast iron rod through the asbes-

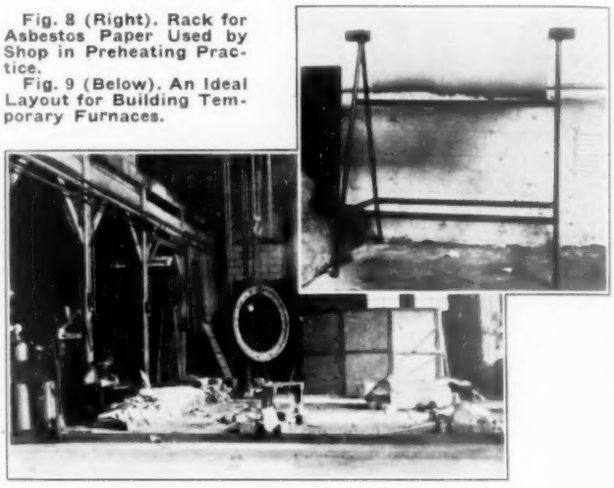


Fig. 8 (Right). Rack for Asbestos Paper Used by Shop in Preheating Practice.
Fig. 9 (Below). An Ideal Layout for Building Temporary Furnaces.

tos paper covering, Fig. 4. The completed cast iron weld may be seen in Fig. 5. Local preheating of a small part by the blowpipe flame is shown in Fig. 6, in which a broken lug is being welded to a cast iron pump base.

A kerosene preheating torch furnished the preheat for the cast iron repair shown in Fig. 7. A large punch press was surrounded by the brick furnace and the preheating flame played through an opening.

In Fig. 8 a large rack for holding a roll of asbestos paper

Fig. 10. An Interesting Type of Permanent Furnace in a Shop.

may be seen. This has been found very convenient by a contract welding shop where numerous cast iron repairs are made which necessitate preheating.

Fig. 9 shows a typical layout for preheating iron castings of various sizes and shapes. A large section of the shop has a fire brick floor, and piles of loose fire brick are at hand, so that a furnace of any size may be quickly built. Another contract shop designed and uses the gas-fired permanent furnace shown in Fig. 10 for various kinds of iron castings.

Bronze-Welding Cast Iron

The welding of cast iron with cast-iron welding rod, however, is gradually being superseded in many cases by the use

of bronze-welding. The melting point of bronze is lower than that of cast iron so it is not necessary to bring the cast iron up to such a high temperature for the welding, thereby lessening the temperature necessary for preheat and also resulting in economies in oxygen and acetylene. The use of local preheat is all that is generally required for the successful bronze-welding of cast iron. This means that large pieces of machinery need not be dismantled in order to make repairs.

Fig. 11 shows the local preheating of a huge press in an automobile factory, and Fig. 12 shows the actual bronze-welding. It will be noted that the rest of the machinery is

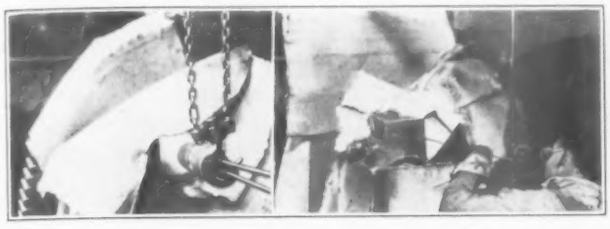


Fig. 11 (Left). Local Preheat Permitted Bronze-Welding in Place. Fig. 12 (Right). Applying the Bronze.

protected from the heat by asbestos paper. The press was reclaimed in place, no dismantling being necessary. Through the use of bronze-welding it is possible to weld crank cases and cylinder blocks without removing the engine from the automobile. A dull-red heat is all that is required of cast iron before bronze-welding. A casting hot enough to char a piece of newspaper is ready to weld with bronze.

Cast Aluminum

Cast aluminum is a metal which always requires a certain amount of preheating before any welding is attempted. In most cases, general preheating is employed and the whole casting is placed in a preheating furnace and brought up to the correct heat. More care is necessary with the preheating of cast aluminium than almost any other metal. Aluminum

Fig. 13 (Above). Gas Torch Maintains Preheat During Welding of Aluminum Casting.

Fig. 14 (Right). Welding Preheated Bronze Gear.

is relatively weak when heated and overheating may cause the casting to collapse of its own weight. For this reason, too, attention should be given to providing adequate support for the casting in the furance. The temporary fire brick preheating furnace, previously described, is the most satisfactory method for the general preheating of cast aluminum. The control of the preheat and the proper regulation of the draft require the constant attention of the operator, owing to the peculiar properties of this metal. If this type of welding is a routine matter in production work, a permanent preheating furnace is recommended. Preheating should be done very slowly in all cases, and the casting temperature must be carefully watched. Cast aluminum does not show red heat before reaching the molten state. It becomes pasty, and it is difficult to tell merely from the surface appearance that the casting has reached the proper temperature. When cast aluminum has become hot enough to char sawdust, it is hot enough to weld. On small pieces, local preheating with a blowpipe will be sufficient to bring the edges to the proper heat. The blowpipe flame should never be held less than 1½ or 2 in. from the metal and should be constantly moved over the part, so as to insure uniform heating.

The repair of a cast aluminum automobile crank case is one of the most frequent cast-aluminum welds requiring preheating. General preheating in a temporary furnace or by a preheating flame, which continues to play on the casting during welding, is nearly always employed. Any badly broken aluminum casting of this type should be placed in the furnace with the middle of the break horizontal and near the top of the furnace, so that the welding may be carried on through the asbestos-cover opening. A cold casting should be brought up to the proper temperature very slowly, the average time being about 30 min. Besides the test with sawdust, the condition of the casting may be tested by using the steel rod to

Fig. 15 (Above). This Bell Was Welded With Manganese Bronze in a Preheating Furnace.
Fig. 16 (Right). Cast Steel Cylinder of Compressed-Air Paving Breaker.

scrape the surface of the metal to make sure that it is not becoming too soft. In the case shown in Fig. 13 only a small break occurred, so that complete preheating was unnecessary.

Monel-Metal and Pure-Nickel Castings

Castings of pure nickel or monel metal, which is a natural alloy of nickel and copper, are quite sensitive to sudden temperature changes. General preheating in a furance is essential to the successful welding of these castings. As in the case of cast aluminum, it is necessary to give the casting proper support while it is in the preheating furnace, so that it will not distort or collapse under its own weight. Pure-nickel or monel castings will, however, show a dull-red heat when a temperature of about 1,200 deg. F. is reached, which is the proper temperature to which the casting should be brought before welding is started, in order to eliminate both uneven heating strains and excessive oxidation which may result from the local overheating of the metal. A dull-red heat should be maintained as steady as possible during the welding operation. The lack of strength of the metal when hot should also be kept in mind.

Bronze Castings

Bronze castings vary so widely in composition and metallurgical characteristics that it is difficult to prescribe a regular procedure to apply to all of them. In general, whenever the casting is of considerable size, preheating should be used. This preheating is general and is usually accomplished in a furnace. Fig. 14 shows a fractured cast bronze gear of large

size which is being welded with high-strength bronze rod after having been preheated in a furnace. It will be noted that the preheat is being retained by an asbestos-paper covering. It was necessary to preheat this gear for about three-quarters of an hour before welding began. Then the operator was able to complete the weld in a little over an hour. Bronze castings become a dull-red color when sufficient preheat has been applied to allow the welding to begin.

Fig. 15 shows a famous bronze bell cast originally by the Paul Revere Foundry in Boston and recently restored by the use of manganese-bronze welding rod. The preheating of this bell for the welding was accomplished by digging a hole in the dirt floor of a welding shop and building a charcoal fire. The top of the hole was covered with asbestos paper to prevent any draft from striking the casting. A job of this sort, however, should never be attempted by any one but an expert as an intimate knowledge of the proper procedure for welding bronze bells is essential if the bell is to ring true. In this repair and the repair of the gear just mentioned, proper preheating was essential in order to maintain both of these castings in correct alignment.

Cast Steel

Steel is a metal which rarely requires any preheating, because of its ductility and toughness. A good steel casting will bend considerably before breaking, and an examination of any broken steel casting will show that it has undergone much distortion before it finally broke. Small steel castings require no preheating at all. Larger castings, however, with thick walls of such design that localized heat of welding might set up strains in the steel, should be preheated to a bright-red color before the welding is started. The design of the casting will determine largely whether the preheating should be general or local. The principles for preheating cast steel are the same as outlined above for the preheating of cast iron. Fig. 16 shows the cylinder of a compressed-air paving breaker with a broken lug, after welding. Owing to the peculiar shape of this steel casting the part to be welded was preheated in a small furnace so that as the broken member was welded the expansion took place equally throughout the casting and the contraction which followed was equalized and caused no strain.

Alloy Steels

Alloy steels contain, in addition to carbon, one or more metals such as nickel, chromium, vanadium, manganese, or molybdenum. For many purposes these alloy steels are superior to the ordinary carbon steel. As the full strength of these steels is developed only after they have been heat-treated under special conditoins, the welding of these alloy steels should be attempted only by shops having adequate facilities for correct heat-treatment.

Before Cutting

Preheating should precede the cutting of high-carbon and alloy steels with the oxy-acetylene blowpipe. Steels with a carbon content of 0.25 per cent or higher should be preheated before any oxy-acetylene cutting is attempted, in order to prevent any harmful expansion and contraction stresses on the metal near the cut edge. High-carbon steel, for example, should be preheated to a temperature of about 1,100 deg. F., so that, while it is being removed from the preheating furnace to be cut, the temperature will fall to approximately 1,000 deg. which is the proper temperature for cutting.

The chief reason for preheating before cutting is that a physical change occurs on the cut edge of a piece of a steel when it is cut cold. This change is unnoticeable on low-carbon steels, which therefore require no preheating. The change consists in a hardening effect along the face of the cut extending from $\frac{1}{16}$ to $\frac{1}{8}$ in. into the metal and is caused by the rapid transfer of heat from the portion being cut to the cold adjacent metal. In the high-carbon and alloy steels, this zone indicates a gradual change in structure. The sudden cooling of the cut edge sets up contraction stresses, as the face of the cut has been heated during the cutting by the blowpipe to a sufficiently high temperature to change the grain structure. High-carbon and alloy steels do not possess sufficient ductility after being suddenly heated and cooled to take care of these expansion and contraction stresses, so that doing the cutting on a hot slab is the simplest and best way of handling the problem efficiently and economically.

The removal of risers in a steel foundry is a good example of a heavy oxy-acetylene cut in which preheating has been found economical. The heat remaining in the castings as they are removed from the molds conveniently furnishes all the preheat that is required. This method of riser removal is especially recommended in the case of high-carbon and alloy steel castings.

Summary

The methods of and reasons for the preheating of certain metals before welding or cutting have been outlined above. It may be noted that the reasons for this practice are both metallurgical and also economical in some instances. Any study of the subject of preheating will serve to emphasize the importance to welders of a knowledge of the beheavior of metals when heated. The difficulties which were encountered in the past in welding some metals were solved largely by an understanding of heat control. The equalization of expansion and contraction stresses and the physical properties of the various metals are matters which the welding expert understands and which act as guides in preheating practice.

The correct procedures for the preheating of the metals most commonly encountered in general welding practice have been discussed in this article, although there are many other metals which require preheating before they are welded.

If the practices outlined above are followed, little difficulty caused by expansion or contraction stresses will be experienced in welding these metals.

PROGRAM NEARLY READY FOR A. W. S. ANNUAL MEETING

The annual spring meeting of the American Welding Society will be held April 22-25 at 33 W. 39th Street, New York City. There is being prepared a fine program of technical papers covering important phases of welding, the details of which will be ready for publication next month. The dinner will be held Thursday evening, April 24th. According to some of the advance information received from the Program Committee, the dinner will be one of the high spots of the meeting. The fine programs of previous years are sufficient guarantee to those interested in welding that it will be worth while to look ahead on the calendar and reserve the above mentioned dates.

BROOKLYN NEWSPAPER HAILS ADVENT OF WELDED BARGES

A recent issue of the *Brooklyn Daily Eagle* gives an interesting account of the performance of the welded barge "Steelweld," which was designed by E. H. Ewertz and which was described in a previous number of *The Welding Engineer*. The newspaper describes the loading of the new welded steel barge with pig copper, about the worst service a barge can be exposed to. In the news story there is included an interesting account of the life of Mr. Ewertz, who came to this country from Sweden about 40 years ago and has been active in ship-building circles ever since. It tells how successful Mr. Ewertz has been in the design of submarines for the United States and for other countries, all of which has been an excellent back-ground of experience for his present activity in the development of all welded ships.

Safety in Resistance Welding

Eye and Body Protection Depends Not Only on Correct Articles of Apparel But Also on How They Are Worn

By J. W. Meadowcroft*

WHEN apprentices receive their first instruction in the operation of electric spot-welding machines, particular attention should be given to the safety devices and tools required and the type of clothing to be worn. The machine operator should be very careful in the selection of the clothing he wears, as an old, torn shirt, coat, or in fact any piece of clothing that has tatters, is apt to become ignited and cause a severe burn.

Cotton garments or those containing more cotton than wool should not be worn. The writer has seen a number of cases of burns caused by sparks or flying molten metal falling upon the fuzzy surface of a shirt or apron. The regular grade of blue shirt commonly worn by workmen seems to be about the safest and cheapest garment that can be worn.

The operator also should wear a leather apron of the proper size to protect him from high on the chest to the knees and also well around the waist toward the back. He should be instructed to wear his apron at all times, and not allow it to become oily or oil soaked without either having it washed off or replaced with another apron.

No welder should operate an electric spot-welding machine unless he has an approved apron adjusted properly to his body. Burlap bags are positively prohibited for use as aprons in any part of our plant. Sad experiences have prompted us to make this mandatory ruling.

When the clothing and apron are found to be satisfactory, much stress should be placed on the selection of goggles. Goggles should be so constructed as to be adjustable for the proper distance between the eyes, and also for comfort from the temples of the

Correct
(Protection afforded the chest, abdomen, thighs, and the sides under the arms.)

Incorrect
(Apron too low, exposing both the chest and the sides to welding sparks.)

Incorrect
(Protection from waist down only; full-sized apron should be used.)

Correct
(The goggles fit closely to the face and no openings are left for sparks to enter between the goggles and the face, and at the same time they are comfortably adjusted so the temples will not hurt the ears or the cups will not scratch the face.)

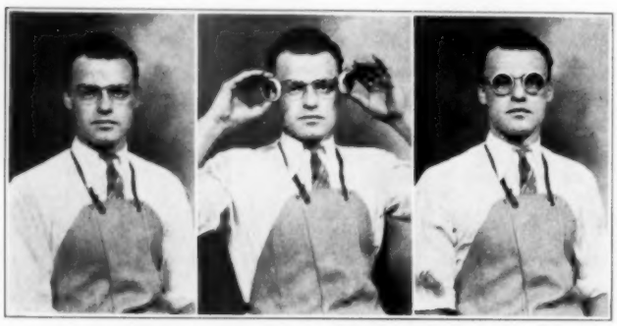
Incorrect
(When goggles are mishandled by carelessly throwing them aside or keeping them in the hip pocket, which bends them out of shape, they will not fit the face comfortably, and furthermore they permit sparks to enter at most any angle under the goggles, which may cause injury.)

Incorrect
(This represents a careless manner of wearing goggles, which gives the operator some protection from sparks while he is looking forward at his work, and may also have the convenience of very clear vision from the top of the goggles when it is necessary to look up. This is only a habit, however, for when a perfect pair of goggles are used and correctly adjusted to the face, clear vision can be obtained at any angle.)

*Assistant Works Manager, Edward G. Budd Manufacturing Co., Philadelphia, Pa.

bows that rest behind the ears. Goggles should be well ventilated, but at the same time they should have side shields and be so adjusted that when they are worn there are no crevices around the outside edge through which sparks or molten metal can enter between the face and the goggles.

Several types of goggles are available which are especially made for those who must wear glasses for eye correction. They are made to fit spectacles of 40 mm. size, and provide full protection to the eyes as well as to the glasses. With this equipment an employee can receive a pair of first-class frames fitted with lenses ground exactly to his prescription, which may be worn by him all day as a pair of shop glasses. At the end of the day he may take them off and put on his regular pair, or wear them continually. The glass in these goggles is replaceable and is also interchangeable with the lens in goggles used by men not wearing



Method of Putting Goggles on Spectacles
(Each half of the goggles is brought around to the bridge of the nose and secured there, without the operator removing his spectacles. Only five seconds are required to put them on or take them off.)

glasses. Thus the fact that an employee must wear glasses does not prevent him from receiving instruction in welding. The illustrations show the ease with which these goggles may be put on over a pair of glasses.

From the standpoint of health, goggles should be issued only after being carefully sterilized, and should not be given to or interchanged with any other operator or apprentice before being sterilized again.

BRITISH TO EXAMINE POSSIBILITIES IN STRUCTURAL-STEEL WELDING

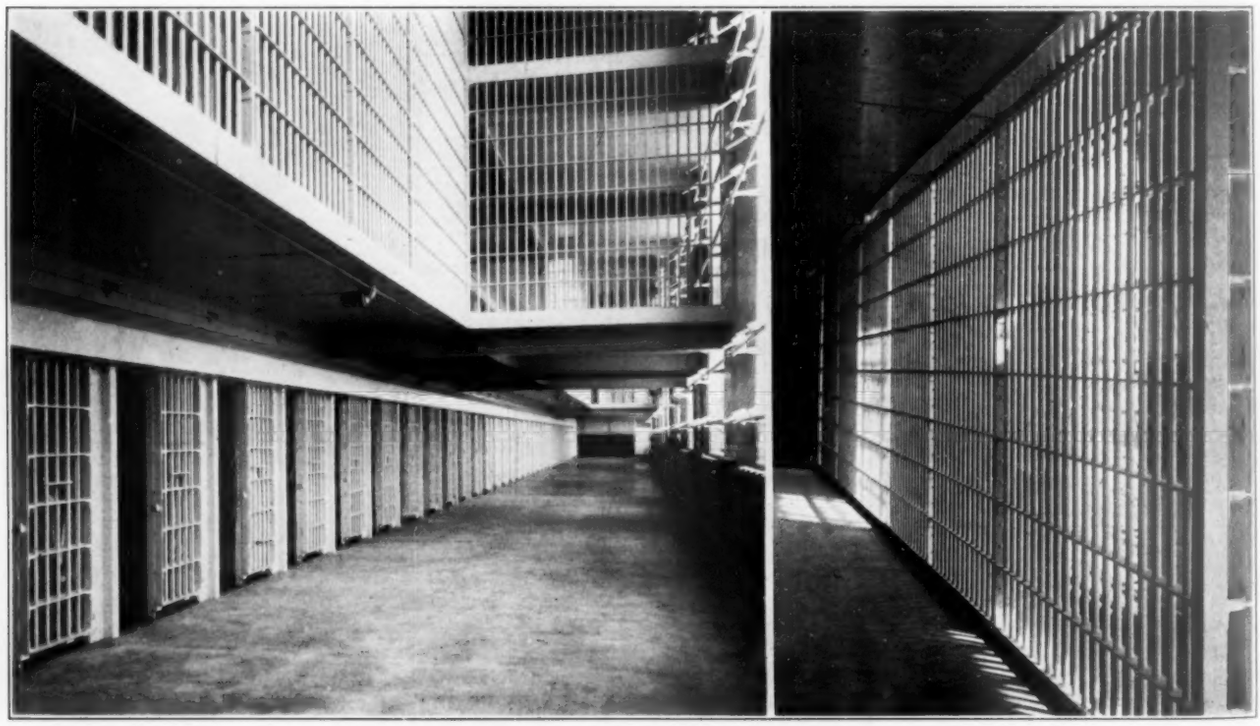
By A. C. Blackall

It is announced that the National Physical Laboratory of Great Britain intends to investigate the possibilities of the use of electric arc welding in the erection of structural steel work, and for this purpose has obtained promises of financial support from the British welding industry. Although arc welding is now extensively employed in the shipbuilding and heavy engineering industries of the United Kingdom, it as yet plays no part in building construction, rivets being used exclusively for jointing on the steel skeletons which form the basis of large modern buildings.

A growing body of experts think it may be both practical and economical to substitute welds for at least some of these rivets, but at present there is a lack of sufficient data to justify experiments on a large scale. This information the National Physical Laboratory should provide. American experience offers indication of the big possibilities, and it is interesting to note that two American experts who were recently in London—Mr. Spraragen and Mr. J. F. Lincoln—both voiced the opinion to their English confreres that welding has proved itself to be satisfactory for this purpose from the technical viewpoint, but that much more work remains to be done before it is possible to estimate accurately its effects on building costs. They pointed out, however, that apart from economic considerations, the comparative noiselessness of the process would prove a big factor in its favor.

PRISON CELLS WITHOUT BOLTS OR RIVETS

To make more secure the confining of the prisoners, the specifications of the new state jail at Caldwell, N. J., provided that the cells should contain no rivets or bolts that could be loosened or taken out. Hence, the structure was welded, the contract being executed by Fries & Son, of Kentucky, using the system of the Electric Arc Cutting & Welding Co., of Newark, N. J. The welding on this structure was thoroughly satisfactory. Willis Wolover was the welding leader and Mr. Corbett the foreman in charge.



Views of Welded Cells in New Jersey State Prison.

Structural-Steel and Pipe-Line Welding*

The Fundamentals of Weld Design and Testing Are Easy to Learn, But Experience Is a Requisite for Proper Inspection

By O. A. Tilton†

THIS subject covers two activities which are very important in the petroleum industry; namely, the fabrication of steel buildings by welding and the welding of pipe lines. It is proposed to outline a few facts regarding the application of fusion welding to these two types of structures.

One of the first questions asked about a welded joint is, "What is its strength?" Then people want to know whether consistent results can be obtained by the exercise of a reasonable amount of skill by the welding operator, and finally how to know, after a job is done, that it is well done throughout.

It is definitely established that the welded joint can be as strong as, and even stronger than, the parent metal. In the design and construction of steel buildings even more than in pipe-line construction, this type of joint was accepted rather reluctantly at first. This is probably a good thing, as a revolutionary change of this sort should not be made where a lack of knowledge of definite characteristics might cause serious results due to improper design. The fundamental facts concerning welding apply as well to structural steel as to pipe lines. That is, in pipe lines, welding is desirable because it is a quick, strong and leak-proof method of joining pipe and makes possible the use of rolled steel sheet or drawn steel tubing instead of heavier or more fragile materials. In buildings it is desirable for the same reasons excepting that of leaks; the factors of reliability and quietness during construction are of prime importance. However, in other respects, these two fields differ quite considerably and so they will be considered separately.

Structural Steel Welding

The characteristics of welds had to be definitely established before they could be accepted. To this end, therefore, innumerable test specimens have been prepared in which welds of many types and sizes have been tested to destruction, and accurate records have been made of their behavior. These results have been coordinated into charts which can be used as a basis for design.

A typical test specimen in which the weld is subjected to shearing stress is shown in Fig. 1. It should be noted that in such test specimens the plates are made so heavy that their strength does not enter into consideration, so it is certain that when failure occurs it represents the ultimate strength of the weld alone.

Results are available covering 242 such tests of metallic arc welds. These indicate the uniformity of strength and reliability of the joints. The tabulated results, in terms of ultimate unit stress in pounds per linear inch of weld, show 10,500 lb. for a ¼-in. fillet weld, 12,000 lb. for a $\frac{5}{16}$-in. fillet weld, 12,800 lb. for a ⅜-in. fillet weld, 16,000 lb. for a ½-in. fillet weld, 20,000 lb. for a ⅝-in. fillet weld, and 24,000 lb. for a ¾-in. fillet weld.

To these values can be applied whatever factor of safety is desired, say four, which gives values that can be used with confidence for design purposes.

*From a paper presented at the International Petroleum Congress, Tulsa, Okla., October 11, 1929.

†Industrial Engineering Dept., General Electric Co.

Unit Stresses with Factor of Safety of Four.

Unit Street, in Pounds	Size Fillet, in Inches
2000	¼
2500	$\frac{5}{16}$
3000	⅜
4000	½
5000	⅝
6000	¾

With this as a basis it is merely necessary to apply enough linear inches of weld to provide the required strength of joint, to equal or even exceed the strength of the plate.

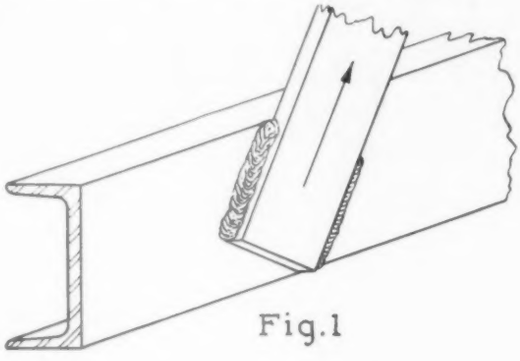


Fig. 1

Fig. 2

Fig. 3

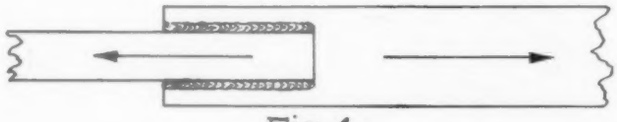


Fig. 4

Fig. 5

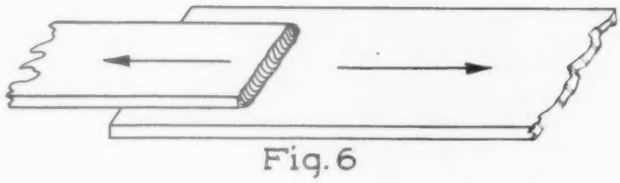


Fig. 6

Inspection

Arc welding can be inspected by both sight and hearing. With very little practice one can come to recognize poor fusion at sight. Porous welds indicate that the speed of travel was too high. Elongated craters indicate too heavy a welding current, and small, shallow craters show too light a welding current. Welds which rust quickly show that the arc was too long and consequently that there has been an undue absorption of oxygen in the molten metal from the surrounding air. Poor penetration, or, in other words, imperfect fusion between the weld metal and the parent metal, can be detected by examining the weld where it touches the parent metal. A joint with poor fusion or penetration looks like chewing gum pressed into the surface, or like Fig. 2. Good fusion has the appearance of the surface of water on the wet sides of a glass, as shown in Fig. 3.

Excessive spatters around the weld usually indicate insufficient reactance in the welding circuit; if this is the case, the joint may still be reliable, although electrode has been wasted by this spattering. Excessive spattering can also be caused by the use of poor electrode wire and, in such cases, the weld may be imperfect and a change to good wire should be made at once.

In regard to the sound of good welding, a few hours' watching and listening to the arc will soon accustom the inspector to the sharp crackling of a good arc or the irregular sputtering and hestiation of a poor arc.

The meters placed on arc welding sets enable the welding supervisor or foreman to know that his operators are using the proper current for the work in hand (this should be specified by the engineer in charge of the job) and that a steady arc is being held. The voltmeter indicates the length of arc. (About 18 volts is correct for the average welding arc.)

Before applying welding to the fabrication of steel buildings, it must be remembered that the problem of expansion and contraction during erection is even more important than in a riveted structure. Bearing in mind the fact that the weld metal is essentially a steel casting, it will be apparent that strains due to expansion or contraction should be transferred to the parent metal rather than left locked up in the weld metal. It is perfectly simple, by a little study, to design properly for welding so that these strains are dissipated in the elasticity of the structure itself.

Another point of prime importance to the design is that the strength of welds is most efficiently employed when the stress in the weld is "in shear" as in Fig. 4. Compression stresses are a little less desirable (Fig. 5), and normal tension (Fig. 6) is the least to be desired.

It is probably very well to bear in mind that the weld should be used as a medium to transmit stresses to component parts of the structure. If this is done then the strength of the structure is dependent upon its component members only.

Pipe-Line Welding

Although strength of joints is important in this field, the major factors are low construction costs and freedom from leaks. Porosity, penetration, and such characteristics that will make it easier to understand the other factors involved, have already been discussed. As far as the weld itself is concerned, the engineer can specify the value of welding current and other factors to give proper fusion or penetration.

There are four types of joints that may be used: namely, the butt joint, the bell and spigot, the bell and spigot with welding dam, and a modification of the butt joint in which a strip of thin metal about $\frac{1}{8}$ x 3 in. is placed inside each joint extending half its width into each pipe and tacked in place in one pipe before the lengths are lined up. The present trend is now towards an increasing use of the butt joint with a backing-up strip, and the bell and spigot with welding dam, as more reliable results can be obtained with less skill on the operator's part and perhaps greater speed in lining up as well as welding operations. As far as total cost is concerned, there is very little difference between the four types of joints mentioned.

The designing engineer will, of course, specify the type of joint to be used. He should also specify the grade and size of electrode wire and the size and type of weld. If proper penetration is obtained, a weld which is approximately 20% higher in the middle than the thickness of the pipe wall will give a joint that is stronger than the pipe itself and, at the same time, the speed of welding will be such that the weld will surely be free from leaks. In general, the following procedure is recommended:

The welding crew is preceded by the lining-up crew which aligns the pipe in long straight sections on wooden skids using metal shoes equipped with rollers. These increase the speed and quality of weld enough to warrant their use. The length of these long straight sections will be from 200 to 500 ft., depending on the terrain and size of pipe.

The lining-up should be done carefully enough so that, if butt joints are used, the ends of the pipe lengths will be about $\frac{1}{16}$ in. apart, without great irregularity. For commercial thicknesses of pipe from 6 in. to 20 in. in diameter, two beads will be required to each joint, using $\frac{5}{32}$-in. wire and about 160 amp. welding current on the first bead, and $\frac{3}{16}$-in. wire and 185 amp. welding current on the second bead. Each welding operator should work from a separate welding generator. Gasoline engine-driven generators are generally most adaptable for this work.

The welding crew should be preceded by a tacking crew who should tack weld each joint to preserve the alignment and hold it until the first bead has been made. The welding crew should consist of four welders for the first bead, six for the second bead, and two for the tie-in welds. They should be distributed two to each long section. Each machine should be furnished with a 175-ft. extension cable and a 50-ft. ground cable. One caterpillar tractor can easily handle the moving of machines as the work progresses for a crew of this size.

In laying the first bead, the operator should begin at the side center of the pipe and weld upward to the top center. He should then move to the other side of the pipe, starting the same as before, and weld upward, meeting the first bead at the top. He then should proceed to the next joint and in the meantime the helper should thoroughly clean the previous bead with hammer, chisel, and wire brush.

When both operators have completed half the first bead on all joints in their section and these have been thoroughly cleaned, the pipe should be turned half around, and all the first beads completed. After all the beads have been cleaned, the operator and equipment are ready to go to the next section.

The second bead should be started at one side, welding toward the top. The first bead has made the joint amply strong so that the pipe may be turned while welding, thus permitting the operators to lay a continuous second bead. When completing the weld, it should be continued onto the beginning of the bead and then curved slightly, ending on the pipe itself. Peening the end of the weld is not necessary in any case.

After the completion of the second beads, the long sections should be lined up on skids over the ditch, the tie-in welds made, and the pipe lowered into the ditch as a continuous tube. Of course it is not possible to turn the pipe for the tie-in welds, and as a result some of the welds must be made "overhead." This requires more experienced operators, and those who are most skillful and most reliable should be assigned to this work.

It now remains to see that operators, foremen and inspectors, and equipment meet the requirements.

It is not always possible to get competent operators in sufficient numbers, nor is it practical to accept an operator as

competent merely on the strength of his own claims. One of the prime requisites for welders is reliability combined with skill and experience. Unfortunately, it is a human trait for men to acquire overconfidence in themselves as they increase in skill and experience. For this reason it is necessary to require each man to perform qualifying test welds. These welds should be made on short sections of the pipe to be used with the specified current and of the dimensions called for by the designing engineer. As the weld proceeds it should be watched closely for:

(a) The holding of about an 18-volt arc.

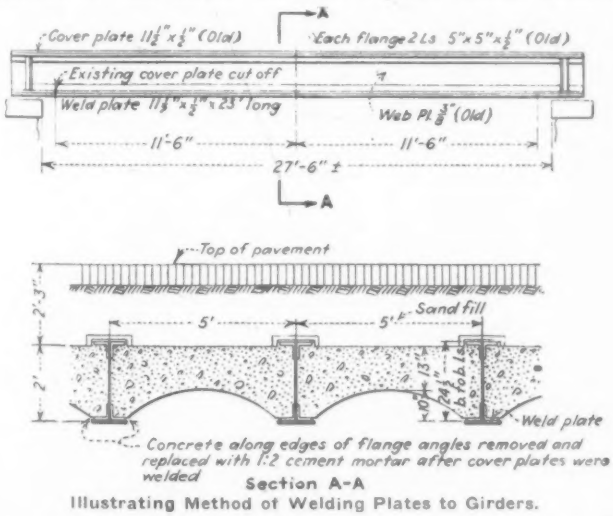
(b) Thorough penetration.

(c) Regular steady movement of the electrode.

Completed test welds should be cut into sections about 1 in. to 2 in. wide. These may be placed in a V-block or in a vise so that, by using a sledge, the coupon may be bent double, with the bend coming directly at the weld. Usually it will not be possible to break a weld made by an experienced operator, but if a fracture should occur it should be examined closely for penetration and for proper appearance of the weld metal. Good penetration will be indicated by the weld metal being torn away irregularly from the parent metal, and the structure of the weld should be close grained and fibrous appearing with a dull gray color. There should be no blow holes, slag inclusions, or brown or blue colored metal.

STRENGTHENING ROOF GIRDERS IN STREET UNDERPASS BY WELDING

The roof girders in the 600-ft. tunnel, between East 157th St. and East 159th St., New York City, through which pass the Port Morris Branch tracks of the New York Central Railroad, presented a serious problem in repair, caused by the corrosion of the bottom cover plates. The roof construction of this tunnel consisted of steel beams spanning



Section A-A

Illustrating Method of Welding Plates to Girders.

between the side walls and carrying concrete jack arches which spring from the bottom flanges, leaving exposed only the bottom cover plate of each beam. The roof, which was constructed in 1898, was finally repaired and strengthened by a novel method employing arc welding, which is described by H. T. Welty, engineer of structures of the New York Central Railroad, in an article on page 642 in the Oct. 24th issue of *Engineering News-Record*.

Restoring the corroded cover plates was decided upon; and electric welding was used, as riveting would have required the undercutting of the concrete jack arches to permit inserting and driving the rivets. A novel method was employed to subject the new plates to dead-load stress.

Starting at one end of the tunnel, the old cover plates were removed from several of the beams, the steel was thoroughly cleaned, and the old rivet shanks were chipped off flush with the backs of the flange angles. At intervals the concrete was cut away sufficiently to permit placing clamps to hold the new cover plates securely in position during the welding operation.

With a plate in position, the first step was to make a continuous 30-in. weld on each side at one end, two welders operating. The plate was then heated by means of torches to about 100 deg. F., or enough to get an elongation of about 0.1 in., corresponding to a stress of 11,000 lb. per sq. in. in the plate. The moment this expansion was secured, the 30-in. welds at the free ends were started, and were completed before the plate had cooled. Thereafter tack welds were made at intervals of 3 in. on each side. Strain-gage readings were taken on several plates, and the measured stress in the plates agreed closely with the stress desired. The flange angles were of course relieved of stress by the amount taken by the plate.

Two gas-driven direct-current 200-amp. welding generators were used, working at 160 amp. and 20 volts during the welding operations. The welding electrodes were $\frac{5}{32}$ and $\frac{1}{8}$ in. in diameter and contained from 0.13% to 0.18% carbon.

The contractor was allowed during the greater part of the working day to use one of the two tracks running through this tunnel, and to block both tracks for limited periods, arranging his operations so the tracks could be cleared at short notice. To accomplish this he constructed a welded structural-steel operating bridge which he mounted on a turntable on a flat car. The bridge in its operating position stood at right angles to the car and parallel to the beams and was supported at its outer end by a temporary wooden post, thus permitting the men to work freely on a cover plate. When necessary to clear up for a passing train, the bridge was readily swung 90 deg. in a few minutes; and if necessary to clear both tracks, the entire plant was shifted to a sidetrack by a switch engine.

EVERYBODY'S BUSINESS

(*Continued from page* 31)

work is unmeasured the rank and file adopt a common gait, largely determined by the efforts of those who are least efficient.

Where the pay is determined by the results produced, the morale of the entire personnel is better, the cost of production lower, labor turn-over is reduced and both wages and salaries are higher.

Especially in the field of selling is it desirable to introduce friendly competition among the employees of a company. A quota-bonus plan tried out in one big merchandising establishment pepped up the entire personnel in a most surprising way. Salesmen stopped spending their time in the smoking room, and telephone calls from customers, that were formerly avoided, came to be regarded as selling opportunities and were answered promptly.

And talking of distribution, nothing else today is regarded as of such paramount importance. The measure of civilization is its buying power. Hard times are always a "supply and demand" problem. If buying power could be kept constant, there would be no more business depressions. Our knowledge of this fact is making us give ever increasing attention to plans for lowering merchandising costs.

Among other things, we now treat visiting salesmen with more dignity and cordiality than heretofore. Wise managers now understand that they cannot be rude and inconsiderate to the employees of others and still expect kindness and respect to be extended to the members of their own sales organizations.

The old-fashioned merchant is being forced out of the picture by the modern retailer who has come to recognize that idle stock is an expensive luxury: that loose credit eats up profits; that an efficient system of stock control is necessary; that success usually depends upon picking money-makers; that

a business cannot be right in the wrong building; and that it is possible to make deliveries show a profit.

Here are a few thoughts that help to make up our new viewpoint respecting selling and distribution: More than half of the consumer's income now goes for services, principally the service of distributing goods. A widely used office article costing $13 to manufacture retails in a nearby city for $50. A certain set of furniture having a factory cost of $110 retails for $380 in a neighboring community. This is typical of nearly all fields of merchandise and is the chief answer to the question of why consumers don't consume. People are able to pay for the commodities they need, but not for their distribution.

Simplification must be used to do away with over-diversification. Years ago hose could be had in only five colors; now a buyer may select from more than 50 colors. Society can save too much. People must be educated to know how to spend as well as how to save. There would be little sense in a plan of thirft based on a public policy of refraining from buying anything except food, clothing and shelter. At times it is a good thing for one to go into debt in a moderate way. Often benefits may accrue to the individual as well as to the corporation from making purchases on a plan of future payments.

Frequently our social standing depends more on what we have and how we live than on what we know or earn. Often it is more to the adanvtage of Mr. Citizen to have a car for which he has paid only one-half than to be without one and have a larger bank balance.

In the days ahead we will witness a greater effort to do away with special sales and mark-downs, which so often bring grief instead of profit, and which in reality represent merely an unfortunate necessity resorted to for the sake of correcting blunders. We will avoid volume sales that show little or no profit, and not over-buy in an attempt to obtain extra discounts.

Fewer brands of goods will be stocked by the average merchant. A recent survey showed that 80% of the people were buying three brands of each of 29 articles although from 30 to 80 brands of these standard articles were handled by the dealers. Sales people will be trained to strive for "permanent" sales so as to reduce the amount of returned goods, which is estimated to involve an expense of $50,000,000 annually to American merchandisers. A study of this problem disclosed that the public is responsible in only 27% of the cases, while wrong selling methods and faulty goods were to blame for the remaining 73%. Clerks must be warned against influencing customers to buy merchandise unsuited to their needs.

Years ago a young fellow named Hartford hit upon a scheme of distributing premium coupons, which plan grew so rapidly that the outcome is now a chain of more than 17,000 stores known as The Great Atlantic and Pacific Tea Company. A country lad took a mass of miscellaneous articles that had been gathering dust unsold for a long time, assembled them on a table and hoisted over them the magic legend: "Everything on this table five cents." The bargain hunters swept the table clear in a day and the result was an idea on which were founded the Woolworth stores.

Greater opportunities than ever before existed are now opening up for people of this kind who are able to exercise originality of thought and action. The battle for the largest share of the customer's dollar has now commenced in real earnest, and it will be carried on by giant chains competing not only with each other, but with powerful independents who have been smart enough to adopt the best ideas and methods of the leaders in dozens of industries. The future is hopeless for anyone in trade or industry today who has failed to recognize the necessity of making his business a precise profession based on no less definite principles and formulas than medicine, engineering or law.

WELDING CONFERENCE AT NORTH TEXAS AGRICULTURAL COLLEGE

The fourth annual welding conference of North Texas Agricultural College was held at Arlington, Texas, March 13th and 14th. This conference has been held every year under the auspices of the Engineering and Trades Department of the College. Among the papers presented in this year's program were the following:

Welcome address by E. E. Davis, Dean, North Texas Agricultural College.

Address: "Advertising the Welding Industry," by J. H. Allison, Vice-President Wichita Falls Daily Times, Wichita Falls, Texas.

Paper: "General Discussion of Electric Welding," by D. H. Deyoe, General Electric Co.

Address by C. C. Rigney, Head of Engineering and Trades Department.

Paper by G. O. Carter, Consulting Engineer, Linde Air Products Co.

Paper by Mr. Hansen of the Northwestern Manufacturing Co., Milwaukee, Wis.

Talking moving picture: "Welding With the Automatic Hydrogen Flame."

Question Box, conducted by W. J. Lacey of Compressed Industrial Gases, Inc.

Address by D. H. Kiber, Head of the Agricultural Department.

Paper by a speaker from the A. O. Smith Corp., Milwaukee, Wis.

Paper: "Possibilities of the Additional Use of the Oxy-Acetylene Flame," by A. J. Fausek, Modern Engineering Co., St. Louis, Mo.

A short discussion on "Problems of Structural-Steel Welding," by Wm. D. Barry, Design Engineer, Austin Brothers, Dallas, Tex.

A generous amount of time was given to demonstrations of bronze welding, aluminum welding, hard-facing, cutting steel and cast iron, and other applications of oxy-acetylene and electric arc welding.

"PREMAG" PROCESS OF GAS WELDING OF COPPER

Considerable interest was shown by visiting engineers at a demonstration of the "Premag" process of gas welding of copper recently given at the plant of the Premier Electric Welding Co. (Newcastle), Ltd., in Newcastle-on-Tyne, England. It was pointed out that an extensive and costly research by the Metals Section of Imperial Chemical Industries, Ltd., demonstrated that the successful welding of copper depends fundamentally on a base material and alloy filler rod of suitable composition, also a suitable flux.

As a result of the acute difficulties of utilizing ordinary tough "pitch" copper in welding operations, a type of copper has been developed which is suitable for welding and can be obtained in that country at the prevailing price for rolled copper.

A suitable alloy filler rod for welding this special copper has also been produced, supplied in various sizes and coated with a deoxidizer, which is important to the success of the process. Among the ingredients in this alloy is silver, which is said to be essential to produce good structure in the weld metal. A cleaning flux is supplied in powder form, only requiring the addition of water to make it ready for use.

In the demonstration referred to, two strips of ⅛-in. sheet copper were butt welded, using a gap of approximately ⅛ in. After cooling, the test pieces were hammered over with the weld as an axis until the faces touched, without any sign of fracture in the weld. A similar test piece, it is further reported, was cut into strips across the weld in an endeavor to trace porosity, but without success.

Hints for the Welder

WHEN YOU FIND a new way to do a hard job, or finish a particularly interesting weld, can you describe how the work was done? . . . . . Have you learned some little stunt every welder ought to know? . . . . . Write to us about these things . . . . . This department helps you welders to help each other. Write up your ideas any old way and just make rough pencil sketches . . . . We'll fix them up for publication.

WELDED JIGS AND FIXTURES USED IN A MOTOR CAR FACTORY

By Geo. T. Kerr

Some of the average-size welded fixtures and dies used in the factory of the Hall Scott Motor Car Co. are shown in the accompanying illustrations, as well as a section of arc-welded shelving. I do not know how many dies this company has that are welded, but certainly it is more than five hundred; and there must be several thousand jigs and fixtures, as at one time the company had three arc welders, one cutter (acetylene), and one layout man working overtime for several months producing arc-welded jigs and fixtures.

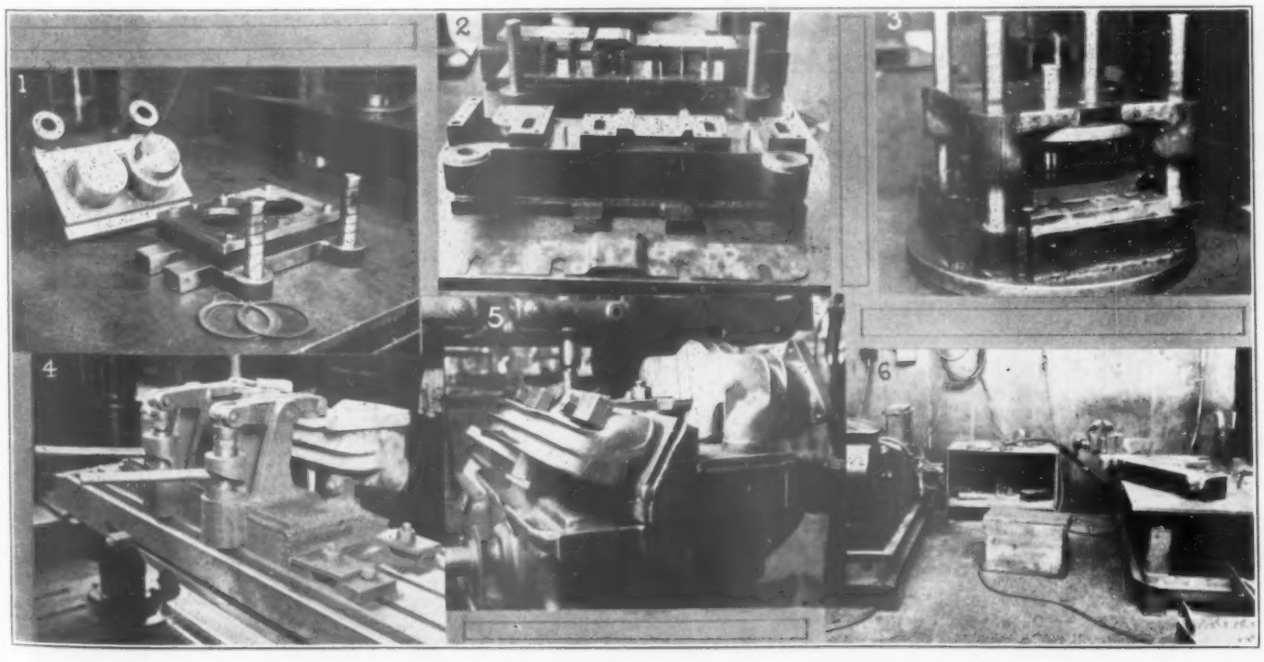
Fig. 1 is a simple progressive die for making a washer. The punch holder and die shoe are made from standard 1x6-in. hot-rolled mild steel. The bosses for the pillar posts and the shank for the punch are welded in place.

Fig. 2 shows a die used to make the baffle plate shown in the foreground. This die pierces, forms, and trims the metal. Cast-iron bushings are pressed into the guides for the pillar posts, as steel would tend to adhere to them.

Fig. 3 is a view of a die used for trimming drawn shells. It is both complicated and heavy, weighing about 200 lb. and there being several parts welded underneath. The cast-iron bosses on the upper section are brazed into the die.

Fig. 4 shows a fixture for milling exhaust manifolds. The uprights in which the clamps fulcrum were spaced correctly before welding and required no machining. The clamps were each made of three pieces, the central piece spacing the sides the correct distance apart so that the equalizing blocks and the camming mechanism fitted without machining. To cite a decided advantage of welded fixtures over cast iron: This particular tool required the

Fig. 7. Welded Section of Shelving Used for Storage.



Typical Examples of Welded Jigs and Fixtures.

addition of two lugs, which were located on the fixture and arc welded in place without removing the fixture from the machine.

Fig. 5 shows a profile fixture for another operation on the exhaust manifold.

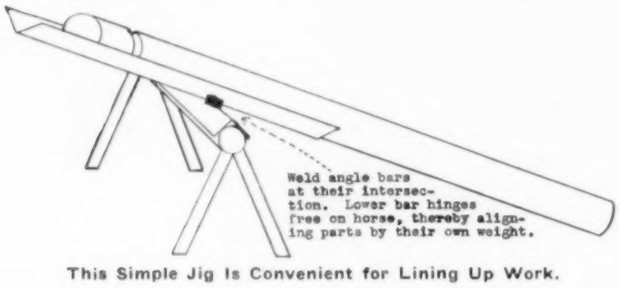
Fig. 6 is an inside view of an arc-welding booth. Note the plug on the wall directly behind the machine; also the two reversing switches, one on the end and one on the front of the machine. These plugs are located at various places about the factory and are used for plugging in electric equipment other than welders, as some of these plugs cause the motor to rotate in the direction opposite to the direction intended. The reversing switch mounted on the end of the arc welder was therefore added. The switch on the panel located on the front of the machine is used when the polarity is required to be reversed, which is the condition when using certain special welding rods for hard surfacing or for welding certain non-ferrous metals.

Fig. 7 is a section of shelving used as a storage space for certain dies. The frame is constructed of 2x2x¼-in. angle iron and is completely arc welded. This section of shelving supports several tons of dies.

SELF-ADJUSTING JIG FOR HOLDING WORK

By G. A. Work

The drawing is that of a jig we have found very convenient for lining up such work as tips on flues, extensions on shafts, etc. The long end of the work may be left on the floor or placed on another horse. The body of the horse is a round shaft, on which slides freely an angle bar, which is welded to another angle bar at right angles to the first. The work lies in the upper angle bar, which automatically adjusts itself to the slope of the piece for working.



This Simple Jig Is Convenient for Lining Up Work.

WATER-TIGHT REPAIR OF LARGE CASTING

A large pump cylinder of cast iron, shown in Fig. 1, was successfully welded by the arc process and the problem of leakage solved by the use of salt ammoniac to corrode the joint between the cast metal and the parent metal.

This cylinder is one of three on a 3,000-g.p.m. pump located in the lower basement of the Harris Trust Building in Chicago and supplying pressure to a hydraulic-elevator system. The diameter of the cylinder is 46 in., the shell is 2½ in. thick, and the valve deck has a thickness of 8 in. The maximum pressure above the valve deck is 200 lb. per sq. in., while a pressure of 24 lb. per sq. in. is maintained under the deck. The valve deck and the shell are cast in one piece.

The shell cracked completely around the circumference, a section of the casting (Fig. 2) showing that the crack started at the corner where the upper surface of the deck meets the shell, and worked down and outward to the outside surface of the shell.

The crack was probably caused by the pulsations in pressure created by the movement of the piston, thus resulting in a breathing action of the shell. To replace the cylinder with another would have entailed great expense and considerable time, as not only would part of the pump have had to be dismantled, but the heavy casting would have had to be moved to one end of the basement from where it could be hoisted to the street above, and the new casting brought in the same way.

Hence, position welding was resorted to, at only about one-tenth the expense of replacement and with a saving of time. The crack was beveled out and 600 ½-in. studs inserted as shown in Fig. 2. Twenty-four ¼-in. tubes were also placed around the circumference, with their inner tips at the base of the weld and the other ends threaded so as to permit an Alemite cup to be threaded on. These threaded ends are shown protruding from the weld in Fig. 1. An Alemite gun was then connected to the cups and a solution of sal ammoniac forced into the rear of the weld and all through the open joints, including the junction of the weld metal and casting, blowholes, and the crack itself. This application rusted the joint

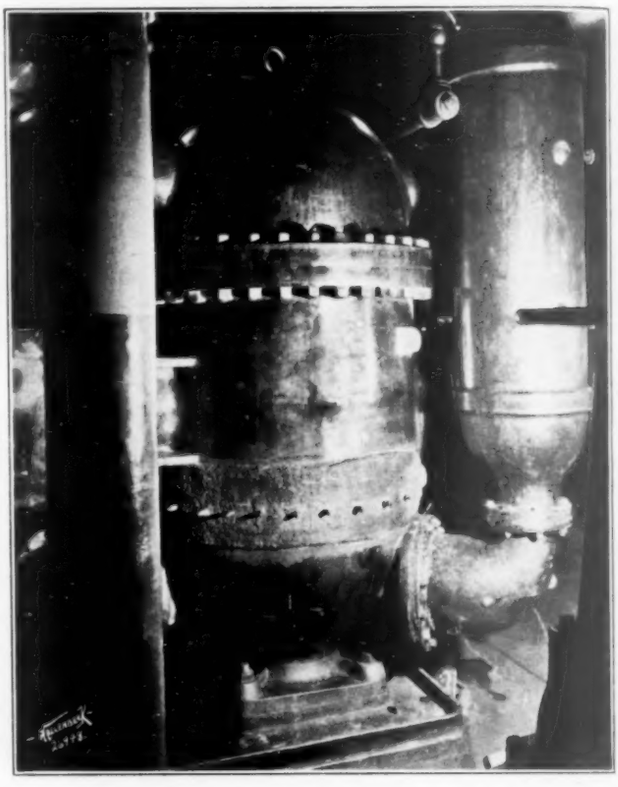


Fig. 1. Large Hydraulic Pump Cylinder, Showing Small Threaded Tubes Imbedded in Circumferential Weld.

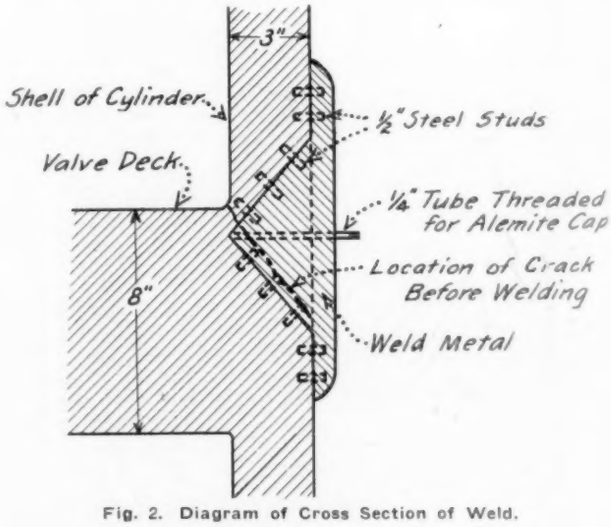


Fig. 2. Diagram of Cross Section of Weld.

of steel weld metal to the cast iron, resulting in an absolutely water-tight joint.

This was not an experimental job inasmuch as a duplicate of this method was employed some three and a half years ago in a casting which has been in successful operation continuously since that date.

The present job as well as the former one was made by the Western Welding & Equipment Co., 1432 W. Lake St., Chicago, Ill.

HANDY PREHEATER AND WELDING TABLE

By R. C. Leibe

In looking about for a handy welding table for my shop, nothing was found that suited our needs for all classes of general welding. We set about to design a table that would contain a preheating unit, together with clamps, hub holes, etc., to facilitate the handling of the work.

Our class of work includes all manner of cog and gear wheels, as well as cast-iron pulleys and other parts. These are hard to hold in place for welding, owing to the hubs being worn uneven and the rims not balancing. To overcome this condition, we made

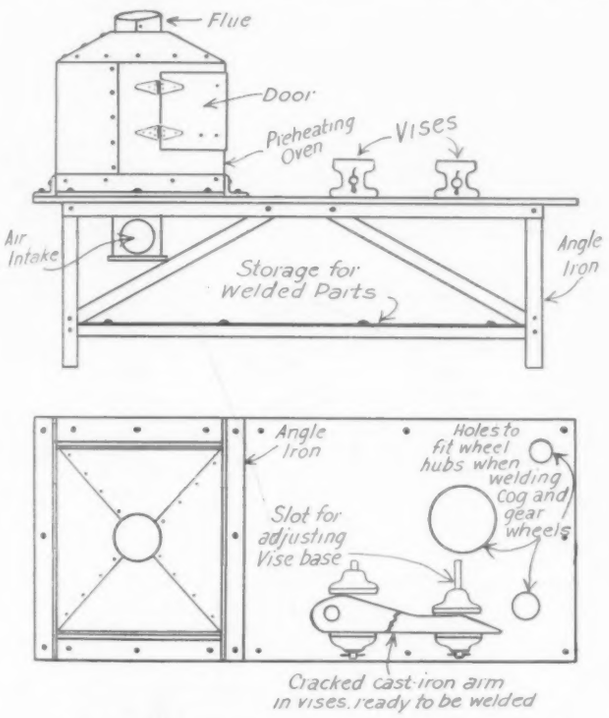


Table for Heating and Holding Work to Be Welded.

several holes of different sizes to receive the hubs while welding so that the rims would lie against the surface of the table. This proved a boon in this class of work.

Next, in preheating many classes of work for the purposes of saving gas and treating for expansion, such parts had to be carried about from forges and ovens to the table and back for slow cooling. Much time was wasted in this manner, as it is in most other shops. So we mounted a preheating oven on the welding table, as shown in the illustrations, which proved to be a real time saver. Work is now preheated quickly in the oven, drawn out for welding, and then returned for slow cooling, later finding its way to the storage platform under the table and, when cold, being dressed up on grinding wheels. Welders will recognize the saving of time and steps in the use of this handy table.

The top of this table consists of a 3x7-ft. sheet of ⅜-in. boiler-plate steel, although the size should be chosen to suit the needs of the welder. The legs, side pieces, and braces are made of angle-iron, having ½-in. flanges, and all pieces are riveted together and reinforced with tack welding.

The oven is built of heavy sheet iron, forming a square, and is mounted within an angle-iron frame which is riveted to the table top. The oven is lined inside with fire brick laid edgewise to conserve space. A pipe leads from the top and connects with the chimney. The oven contains a door having a width equal to half that of the oven, through which parts can be inserted for preheating or be removed, and, if need be, parts can be welded just inside the door.

The table top under the oven contains an opening equipped with grates for the blower system or equipped with an oil burner, whichever is used. A short length of pipe extending below the table top at this point has an ash outlet below and an air intake on the side. We have found that a little fan operated with a ¼-hp. motor is satisfactory. The shut-off member at the air intake may be opened or closed to admit as much air as wanted, or any forge fan may be attached to the table edge and the air line run into the opening beneath, if a hand blower is desired. Charcoal or fine coke makes the best non-smoking fire for preheating. The draft may be used to keep the fire going for long periods of time.

Another desirable feature of this table was a pair of small machinist's vises mounted near one edge, for clamping and holding broken parts end to end for tack welding to prevent the parts from slipping or from getting out of line, which had resulted in the loss of much time and gas. One vise is mounted stationary, while a slot in the table top allows the other vise to be moved to any position to accommodate parts having bends, curves, offsets, etc.

The entire table, except the sheet metal top, is constructed of angle iron.

TESTING WELDS WITH THE STETHOSCOPE

The stethoscope, the familiar instrument of the physician, holds possibilities as a detector of good and faulty welds, according to an article appearing in the January 1930 issue of *Oxy-Acetylene Tips*. A welded plate, for example, is tested by holding the rubber tip of the instrument against the surface of the plate while with a small hammer the inspector strikes the spot in the weld that is under examination. The weight of the hammer and force of the blow depend upon the thickness of the plate, and the stethoscope is applied to the plate in the general vicinity of the striking zone.

The sound heard at the instant of first tapping the welded joint is critical and is a function of the character of the weld at the point struck. Shortly after the tapping, the waves are reflected, and the sound picked up by the stethoscope becomes a composite of the natural vibration of the plate as a whole and of the forced vibration of the material immediately under the striking hammer. When the defect is very serious, however, it has a damping effect on the total sound, so that its presence is also clearly evident in the after-ring.

Each welded structure has a characteristic sound. After this is determined by brief preliminary tests, the striking hammer and stethoscope are moved along the weld so that any irregularities are discernible. This method has been applied to welds in pipes and pressure vessels, to a number of specially made welds in plates, and to welded structural steel joints. The last named were made with intentional defects unknown to the persons making the tests, and in each case the locations of the defects were correctly determined by the use of the stethoscope.

Two large tanks were tested with the stethoscope and no defects were noted in either the longitudinal or girth seams. In the case of one of these tanks, the acceptance hydrostatic pressure test failed to show any defects. In the case of the other tank, which was tested to destruction, failure occurred outside the weld.

The nature of the defects located by the stethoscope is of decided interest. Lack of fusion, particularly at the bottom of a V or along the scarf, gives a characteristic reedy, high-pitch initial note. In many instances the points at which welding has been started and stopped and where tacks have been made are discernible with the stethoscope, but the characteristic tone is such that these points are readily different owing to lack of fusion. It was found that different individuals were able to check each other in a most satisfactory manner in the testing of welded plates, pipes, pressure vessels, and welded structural joints.

In applying the stethoscope, it is necessary to hold the end of the main tube firmly against the plate so that sounds from the plate only are heard. The stethoscope may be applied on any part of the structure near the point struck; but it is advisable to hold the instrument in one position as long as convenient, as this tends to accentuate differences in sounds. Usually the hammer is struck directly on the surface of the weld, but striking within 1 in. of the weld on either side gives good results. The force of the blow need not be constant, but may be varied to suit the thickness of the plate and the sensitivity of the ear of the operator. The characteristic reedy tone of a defect is sufficiently different from that of a satisfactory spot that any one with a normal hearing and a little experience can readily detect the difference. Special attention must be given to the sound that is heard just as the hammer hits.

A number of different-quality sounds are heard, but the tester is able to eliminate the irrelevant sounds in his ear and concentrate on the proper ones.

Application of the stethoscope is a development of the familiar

Manner of Testing a Weld With a Stethoscope.

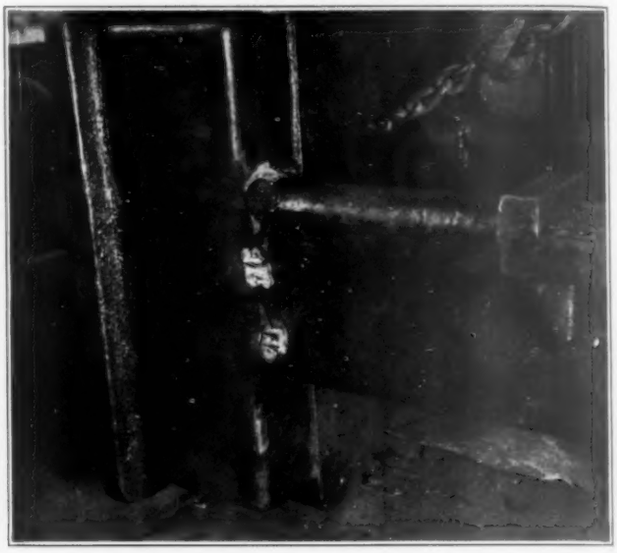
method of testing the soundness of a metal part by the ring when struck with a hammer or sledge. Welders quite frequently test large welded castings by suspending them and noting the clearness of the sound produced when struck with a hammer.

This entire subject has been studied carefully by the Union Carbide and Carbon Research Laboratories, who also conducted parallel studies in which an X-ray method was developed whereby the actual strength of the weld at the defective point as indicated by the stethoscope can be estimated to within 3,000 lb. per sq. in. The entire investigation forms a most important contribution on the subject of non-destructive testing of welds.

ALIGNING CASTINGS FOR WELDING

Heavy broken castings are successfully welded at the plant of the Anchor Welding Service, Inc., 4715 West Chicago Ave., Chicago, by tack welding the broken pieces together with the arc before the castings are preheated prior to the main welding operation. The illustration is that of a large machine base which has been tack welded with G-E cast-iron electrodes at the point of fracture. The casting is then preheated to the welding temperature, following which the welding torch is used to melt out the metal in the fracture to perhaps half of the depth of the section. New metal is then deposited in the veed-out area. When the welding is completed on one side the casting is turned in the fire and the rest of the fracture welded. In thinner sections it is possible to complete the weld in one operation from one side.

While the electrode used in making the tack welds is especially adapted to arc welding cast iron it is still essentially a steel material which will be detrimental to a deposit of cast iron. Therefore in cutting out the fracture, the welder should be careful to see that none of the tack metal is allowed to be fused with the weld metal. As either the veeing or welding reaches a tack it should be heated until almost molten and then removed entirely with the rod. One of the advantages



Large Casting Tack Welded Before Preheating.

of tack welding with the arc before preheating, according to George Hettrick, president of the Anchor Welding Service, Inc., is that as the cooling weld metal contracts it draws the parts snugly together; hence, the alignment is held perfectly true in the completed casting.

WELDING USED EXTENSIVELY ON LARGE BREECHING

What is said to be the largest breeching ever made in the South was recently completed by the J. J. Finnigan Company of Atlanta, Ga. This breeching is to be used in connection with a mammoth boiler in one of the government departments in Washington, D. C. While it was not an all-

This Large Power-House Breeching Was Fabricated With the Aid of Cutting and Welding Torches.

welded job, its fabrication involved the use of a considerable amount of electric and oxy-acetylene welding. All of the inner seams were welded and the oxy-acetylene cutting torch was used in cutting out the plates. Work on it was started January 1st, and shipment was made to Washington on February 14th. The job has excited quite a bit of comment among the boiler and tank men in the South. The fabricators, J. J. Finnigan Company, were established in 1886, and their reputation in this field extends to many countries. They have shipped and erected oil tanks in Russia and

South America as well as in the oil fields in Texas. They state that this is one of the most interesting jobs which they have had in recent months. Acknowledgment is made to Mr. R. G. Wilson, District Sales Manager of the Burdett Oxygen Company, Atlanta, Ga., for supplying the photograph and information regarding this interesting job.

AN ALL-WELDED MACHINE-TOOL BASE

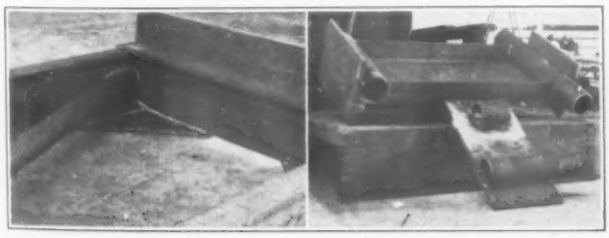
By Miles C. Smith

Much has been said pro and con relative to the possibilities of replacing castings with welded steel fabrication, but it is doubtful if a better illustration of welded steel fabrication exists than is exemplified in the recently perfected Stoody Universal oil-tool grinder. This machine, which occupies a floor space of approximately 3½x8 ft. and weighs approximately 2,500 lb., is built almost entirely of steel plate, shaped with a cutting torch and welded in place. Even the longitudinal and cross ways are ground shafting, held in place by poured babbit. Every integral part of the entire assembly is a departure from the conventional type of design and fabrication.

(Left) An All-Welded Machine-Tool Assembly.
(Right) End View of Machine Base, Showing Fabrication Details.

The base of the machine is formed from ⅛-in. steel plate, welded at the corners and further strengthened by a welded-in steel-plate bottom for the water pan. For further rigidity of the base, a diagonal stay in the form of a pipe is welded from one corner to the alternate one.

Atop this base on each side is welded a 7-in. structural channel with the flanges to the inside. At the ends, welded to the ends of the channels and to the base, are two formed plates, one of which extends up to form the spindle support, and the other, at the tail of the machine, supports the two sockets for the longitudinal ways. Both of these plates are ½ in. in thickness. Setting at the front of the spindle is another ½-in. plate which rests upon the two channels and which also carries the other two sockets for the longitudinal ways. The two plates forming the spindle support are joined together by welding in two more plates.



(Left) A Detail of One Corner, Showing the Joining of the Pipe Diagonal Stay, 7-In. Channel, End Plate, Gusset, and Water-Pan Bottom.
(Right) Welded Carriages for Cross and Longitudinal Ways.

As fabricated, this base is extraordinarily strong and rigid, although of relatively light weight. Inasmuch as this machine was never designed or fabricated with a cast-iron base of the conventional type, there is no opportunity for comparison between the cast-iron construction and the fabricated steel construction, but it is safe to say that strength has been acquired far beyond any possibility with castings of reasonable weight.

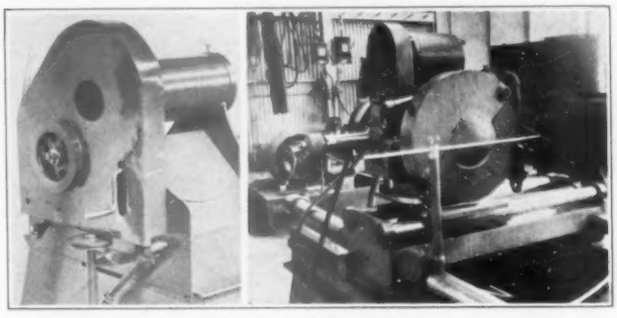
Quite as interesting as the base is the fabricated carriage. This carriage is formed entirely of steel, welded in place, and travels on the longitudinal ways on babbited supports. Similar construction is used for the cross ways and cross travel.

Viewed from a production angle, the round ways and their method of attachment, as well as the method of travel on them, are most interesting. The ways are lined up and held in place by being imbedded in babbit, while the travel is also on babbit that has been poured and then scraped to a fit. This type of construction assures accurate rigidity, yet is remarkably easy to fabricate; furthermore, it lends itself to easy replacement should replacement be necessary.

The spindle housing is another interesting part of the assembly and consists of steel tubing machined at either end to fit the spindle bearings and welded to the ½-in. steel-plate supports.

In fact, every integral part of the entire assembly which does not necessitate any provision for frequent removal or adjustment is welded in place, and in nearly every instance the welding is done with the electric arc. The general procedure is to spot the parts in place first and then run a continuous bead along all seams, so that the entire machine actually becomes one continuous steel unit which should withstand years of the most severe service without weakening.

Whether or not this type of design and fabrication will become general in the construction of machinery and machine tools is problematical; but in this one instance, at least, it has proved its worth in many ways. While this particular class of machine lent itself to such a design—much more so, no doubt, than would many other types of machinery—yet, at least for the bases, it would seem that the adoption of steel plate, welded together, would not only result in greater strength and less weight, but would as well result in greater economies in production.



(Left) An All-Welded Guard. This Also Illustrates the Method of Welding in the Spindle Housing.
(Right) The Welded Carriage Shown on Its Round Ways.

At the Stoody Company plant, where these machines are being produced on a production basis, the work goes along with surprising rapidity and with the use of only the simplest types of jigs and fixtures. A certain amount of inaccuracy in the fabrication of the base may be compensated for in the method of locating and securing the ways and other integral parts, so that the completed machine is accurate to the highest degree.

Furthermore, welded construction readily lends itself to a satisfactory and economical method of attaching accessories. In this particular machine there is a drip trough along either side which would entail much care if it be formed on a casting. With the welded construction, it consists of a long steel strap and two end pieces, all welded in place.

WELDING PIPING FOR STEEL STRUCTURES

By John H. D. Blanke

The results of some interesting tests of the strengths of transmission towers made of rolled shapes, or welded of pipe either in diagonal or box design, are reported by A. Hilpert and O. Bondy in the *V. D. I.-Zeitschrift* (1929), *73*, 24, pp. 805-810. The results obtained assure a new field of enterprise for the welding industry. The automobile and the airplane industries and also the tubular furniture and other special industries have already taken advantage of the features of strength offered by the cylindrical cross-section of piping for structural work.

The special advantage of pipe cross-section is that the moment of inertia is equal in every direction; so that with the use of a

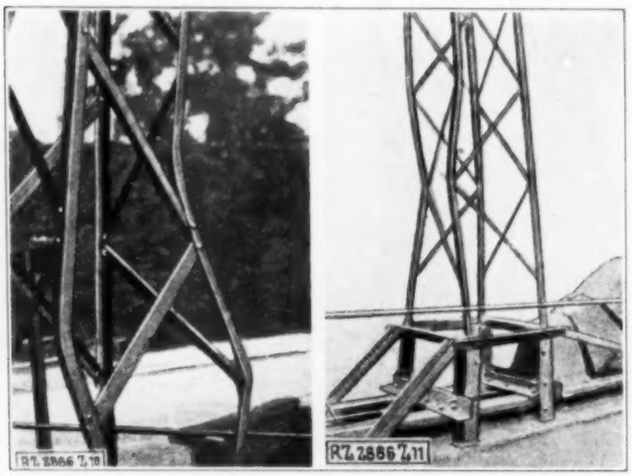


Fig. 1 (Left). Tower of Riveted Angle Iron, Showing Failure Under Test Load.
Fig. 2 (Right). Tower of Welded Diagonal Pipe, Showing Failure Under Test Load.

minimum cross-sectional area and consequently with the minimum of weight, the maximum resistance against breaking is attained. This fact, known of old, could up to the present not be utilized much in structural work, because riveting and bolting on of the piping proved to be very impracticable, and the static advantages obtained in the pipe itself were eliminated by the fact that the tubes had to be changed at their points of junction with other

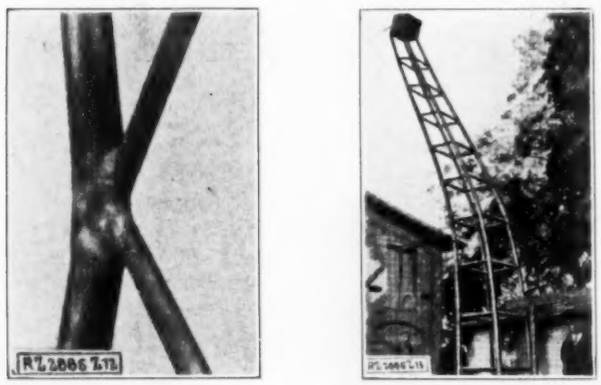


Fig. 3 (Left). Welded-Pipe Joint of Tower Bent Under Test Load.
Fig. 4 (Right). Tower of Welded Horizontal Pipe, Bent Somewhat in S-Shape Under Test Load.

sections into a cross-section suitable for riveting and bolting on.

But since the time that it has become possible to weld such piping, especially of thin-walled section, by means of gas fusion welding, a change in the application of piping to structural work has occurred. In order to determine the possibilities of application of welded jointing in structural steel work, comparative tests were made with latticed masts or towers. These tests were intended to pave the way for the application of welding in one section of the structural steel field—in the construction of buildings, bridges, etc.

Two types of pipe construction were given consideration: the seamless drawn tube, and the tube welded along the lateral seam. The considerably lower price for welded pipe as compared to seamless pipe leads to a preference of welded piping. In order to save in weight, tubes of a thin-walled cross-section and of a large diameter were used. They were then welded with oxy-acetylene equipment.

The tests were made with three 19.75-ft. and a number of 39.5-ft. latticed masts of riveted and welded construction, including several designs of welded towers.

It is of interest to note here that the following clause has been admitted into the new specifications for heavy voltage lines of Jan. 1, 1928, of the Association of German Electrical Technicians:

"Welded masts are admissible, if the welding is done in such a way that at least the same safety of connection is assured as in riveting. The specifications for riveted masts apply in sense also to welded masts."

This has opened the way for the use of welding in the construction of electric transmission towers.

The difference in the results of tests of the riveted and welded towers is vividly shown in Figs. 1 and 2. The 19.75-ft. riveted mast of angle iron failed when the test load being applied reached 3,080 lb., or 3½ times the service load. The place of failure is shown in Fig. 1. The 19.75-ft. pipe-welded mast, with diagonally located cross pipes, broke only after the test load had reached 3,520 lb., even though the weight of this mast is only 55 per cent

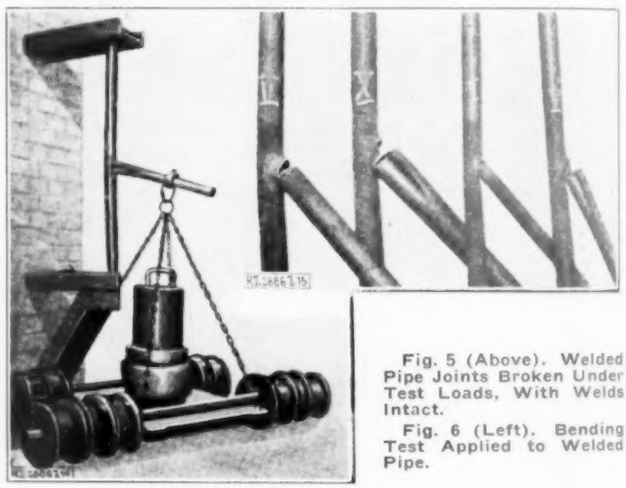


Fig. 5 (Above). Welded Pipe Joints Broken Under Test Loads, With Welds Intact.
Fig. 6 (Left). Bending Test Applied to Welded Pipe.

of that of the mast of riveted angle iron. In this case the welded seam of the diagonals was not damaged under the test load, as Figs. 2 and 3 show.

The masts designed with horizontal cross bars instead of diagonals behaved differently in the tests. Fig. 4 shows a welded pipe mast of bar design when bent under a test load of 2,970 lb. Due to the good strengthening effected by the 5-mm.-thick head plates, the mast bent into an S-shape instead of breaking as in the diagonal design shown in Fig. 2. Hence the design with horizontal cross bars is apparently to be preferred.

The tests on welded pipe joints proved that it is best to use the circular pipe cross-section also at the pipe joints. Fig. 5 shows that when a test load is applied to a horizontal pipe welded to a vertical pipe, the vertical pipe bends first, and then the horizontal pipe breaks, but as a rule not at the welded joint. When using pipe of 2-in. diameter and 2.5-mm. wall thickness, both the vertical and the horizontal pipe bent under a test load of 895 lb. as shown in Fig. 6, but the welded seam again held.

In the tests of the 39-ft. masts, the superiority of the welded pipe structure as compared to the riveted angle-iron mast was again proved. These tall masts were built in two separate sections, each 19.5 ft. long. These sections were then welded together as shown in Fig. 7. Joint sheet plates were welded into the slit pipe ends. They could have been shorter than used here. This kind of welded butt is much simpler than the weld with

bent fish plates or sleeves. This kind of joint can be welded in the field, either before or after the first section is raised.

The tests have shown that comparatively low-priced thin-walled pipes may be used successfully in the place of rolled shapes for the construction of towers. Welded construction saves in material, shipping charges, etc. Furthermore, pipe offers less resistance to the wind than standard rolled steel shapes, and is of better appearance.

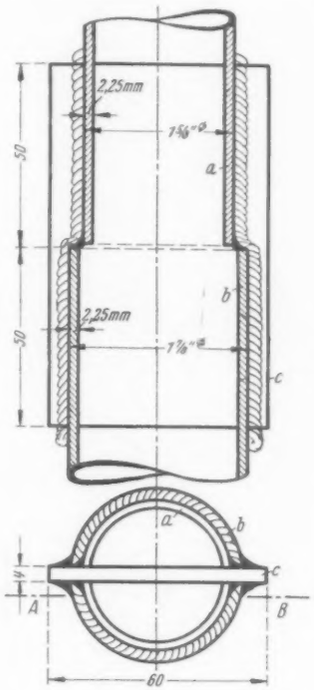


Fig. 7. Ends of Two Pipe Sections Joined by Welded Plate.

Owing to the absolutely solid weld, the danger of corrosion, so common with riveted construction, is eliminated from the joints.

The comparative figures obtained in these tests are as follows:

Material	Angle Iron		Welded Pipe		
Type of joint	Riveted		Welded		
Design	Diagonal		Diagonal		Horizontal
Height, ft.	19.75	39.50	19.75	39.50	19.75
Weight, lb. (W)	380	128	209	409	273
Breaking load, lb. (B)	3,080	3,080	3,520	2,860	2,970
B/W	8.1	4.23	16.8	7.0	10.9
Ratio of utilization of construction material	1	1	2.07	1.66	1.35

WELDING SOLVES DIFFICULT PROBLEM OF STEAM-MAIN INSTALLATION

When it became necessary to run a large steam heating main from one point in the plant of the Edison Electric Appliance Co., in Chicago, to a new building several hundred feet distant, it was decided to take advantage of an arm of the factory building which extended almost the entire distance between these two points and had I-beams located along one side of the building near the roof which could be used for supporting the pipe, thus eliminating the need of installing hangers for the new main. These beams were about 25 ft. above the floor of the building.

As 14-in. pipe was to be used, and each section weighed about 950 lb., it would have been extremely difficult, if not impossible, to lay flanged pipe sections across these beams, which were spaced 10 ft. apart along the length of the building. Hence it was decided to use pipe sections beveled for butt welding, these to be arc welded, section to section, at one end of the building and the pipe moved along on top of the I-beams as each section was welded on.

This operation was facilitated by the fact that one end of the roof was flat and at a somewhat lower level than that part of the roof over the I-beams which were to support the pipe. The pipe sections as they were to be welded were hoisted onto this flat section of the roof, and the joints were welded under a temporary canvas booth.

To assist in moving the pipe as each section was added, rollers were mounted on the I-beams, the construction of these being shown in Fig. 2. The pipe was pushed through a temporary hole in the wall and over these rollers, from the end where the welding was being done; and when the length became too great to allow handling in this manner, block and tackle were used.

Fig. 1. This 14-In. Steam Main, More Than 400 Ft. Long, Was Forced Through This Maze of Steel Beams as Each Section Was Welded on at the Near End.

In addition to this straight-away run of more than 400 ft., this main also has five welded elbows, four of which are located in a short section at one end, the other elbow being at the other end of the main.

Trap drains were welded into the main without the use of fittings, making a very neat job. The entire main was covered with insulation, this being a much easier operation than if the pipe sections had had flanges.

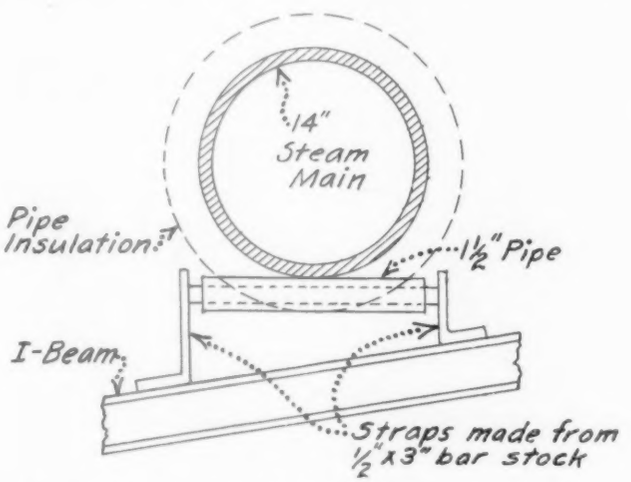


Fig. 2. Illustrating Design and Mounting of Rollers.

The main carries steam at about 5-lb. pressure. The entire job was erected complete in 1,100 man-hours.

Because the long, narrow room through which the straight section of the main runs contained products of the factory crated and ready for shipping, the fire hazard from welding in the building itself had to be given consideration.

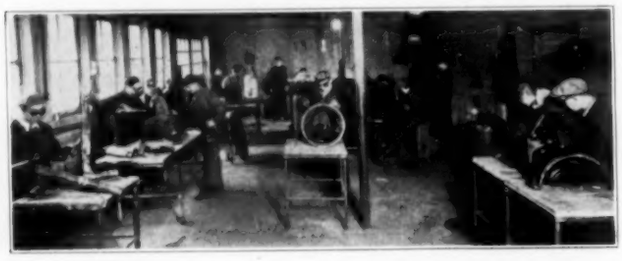
OMAHA AIRCRAFT COMPANY CONDUCTS WELDING SCHOOL

The Rapid Aviation group of aircraft companies is conducting a school for aircraft welders at 2200 Franam St., Omaha, Neb. A mailing circular issued by Rapid Aviation, Inc., gives information concerning the course and prevailing rates of pay for competent welders, and shows several views of welding departments in large aircraft factories. By becoming competent welders, it is pointed out, men and boys can use this trade as the door through which to enter the expanding aircraft industry.

SYRACUSE SCHOOL SHOWS GROWTH

The growing interest in welding is being reflected in the increasing number of students and the expanding facilities of the National Welding School, 424 South West St., Syracuse, N. Y., which was opened last August to teach both electric and acetylene welding. Felix O. Blixt, of the Blixt Welding Works, a man with 20 years' practical and theoretical training in the welding industry, was selected to take charge of the instruction and associated with him are several assistant instructors.

The equipment includes a.c. and d.c. welding machines and a 100-lb. acetylene generator, with a complete line of



Where the Rudiments of Acetylene and Arc Welding Are Taught.

torches. Students receive both flat and overhead practice on boiler plate, pipe, and other material, and they are taught to handle the torch on iron, steel, brass, cast iron and aluminum. The student first learns the theory of welding, by blackboard talks and discourses. Later he does the actual work as outlined to him.

A term in the school consists of 165 hours' training, the student in the day class attending from 9:00 a. m. to 4:00 p. m.; and if he is employed in the night time, attending the evening class on Monday, Wednesday and Friday nights from 7:00 p. m. to 9:00 p. m.

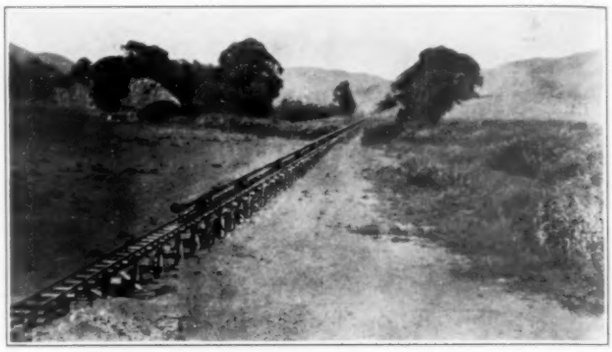
Cast iron and aluminum welding, overhead electric welding, and other operations that are generally considered as requiring an unusual amount of skill, are being successfully taught in this school, says Philip Leitze, the manager. An employment department is maintained for the benefit of the students.

LARGEST UNDER-WATER OIL LINE IS WELDED AND LAUNCHED

Oil from the Kettleman Hills is conveyed to Estero Bay on the Pacific Coast through a 70-mile pipe line recently completed by the Standard Oil Company of California. This line, which is of 10-in. pipe, is completely welded and carries oil under an initial pressure of 1,000 lb. per sq. in. to storage tanks on the coast, no booster-stations being used.

Since a deep-water harbor is not available at this point, a 16-in. submarine pipe line has been constructed to carry the oil from the storage tanks on shore out to the tanker anchorage 3,000 ft. at sea. At this point the oil is loaded for transport to the refineries by means of a hose attached to the seaward end of the pipe and connected to a buoy by a chain. This submarine line, in order to assure freedom from leaks, was entirely welded by the oxy-acetylene process, the standard open-vee butt weld being used without straps or any reinforcements.

One of the most interesting features of this line is that it was entirely constructed on shore, a narrow-gage railroad extending 3,000 ft. inland in a straight line on a 2 per cent grade having been constructed especially for the purpose.



Welded Pipe Line Before Launching in Sea.

All welding was done at the inland end of the track, and as fast as lengths of pipe were added to the line at this point it was moved forward toward the shore on trucks running on the narrow-gage tracks. The illustration shows the complete portion of the line on its way toward the sea. When completed the end of the line was capped, equipped with a sled and towing bridle, and pulled out to sea by means of a tug. A hydrostatic test showed that the welded line had withstood the launching operation perfectly and was ready for service.

OKLAHOMA CITY TO HAVE WELDED FACTORY BUILDING

An all-welded factory building will be constructed at Oklahoma City by Black, Sivalls & Bryson, Inc., of Bartlesville, Okla., it has just been announced. This concern manufactures welded vessels and equipment through its subsidiary, The American Tank Co., of Oklahoma City. This factory will be erected on the site containing about ten acres in the southwestern part of Oklahoma City at Westwood Blvd. and Popular St.

The main building will be 140 ft. wide and 260 ft. long. Its construction is of the half-monitor type, and the height of the main section is 45 ft. to the top of the roof. The side walls will be galvanized metal with very large window areas. The entire floor will be a 6-in. concrete slab. Only three rows of columns will support the structure and crane-way. The entire area will be served by overhead traveling cranes, resulting in the greatest possible efficiencies in the manufacturing process. One of the cranes will be 60 ft. wide and of 5-tons capacity, to serve the machinery and preliminary phases in the process of manufacture. The other crane will be 80 ft. wide and of 10-tons capacity; this crane, which is of unusual width, will serve the assembly floor, and will have a lift of over 30 ft. above the floor. The building will be served by switch tracks running inside and across the entire width, which will result in economical loading and unloading of materials.

As evidence of the faith in modern welding practice and efficiency, this building will be made of welded members. Not a rivet of any kind will be used in it. This is the first time a project of this kind has been attempted in the Mid-Continent area. The structure has been so designed that it will support the heavy loads of both cranes.

Black, Sivalls & Bryson, Inc., who for more than twenty years have been serving the oil industry, are also designers of this building, which will be one of the most modern and fully equipped shops of its kind. The products to be manufactured at this plant will consist of many articles which are now manufactured at the

old plant of the American Tank Co., including the American patented oil and gas separator, welded oil-field tanks, welded bulk-storage and filling-station tanks, welded refinery equipment, welded piping, building caissons, bridge piers, packing house vats, condenser boxes, pressure drums, and other welded products manufactured according to specifications.

The demand for welded equipment has been increasing so rapidly in the past few years that the old Oklahoma City factory has been far behind in its orders. The increased capacity will afford the customers of these concerns the superior qualities and economies of modern welding, which will be possible through the installation of the latest equipment and properly planned shop practice.

There has been considerable new equipment purchased for use in the building, including an enormous squaring shear capable of cutting through ¾-in.-thick flange steel, 10 ft. long. Other items of equipment will be tremendous bending rolls, and flanging, punching, planing, boring, and drilling machines, also automatic welding machinery.

The Engineering Department of Black, Sivalls & Bryson, Inc., which is located at Kansas City, Mo., plans to have the plant completed and in operation by June 1st.

U. S. S. R. HAS WELDING MAGAZINE

About a year ago, a Welding Bureau was organized in the U. S. S. R. as a part of the Supreme Economic Council. This Bureau has charge of matters pertaining to the supervision and development of the welding and cutting industry in the Soviet Union. The Bureau has begun to publish a monthly journal under the title, "Avtogennoie Delo" (Welding Industry). This will undoubtedly be of interest to firms and organizations who may wish to keep posted on the development of the welding industry in Russia. The address of the Bureau is: All-Union-Committee on Welding, Supreme Economic Council, Delovoi Dvor, Moscow, U. S. S. R.

BUILDING UP STREET-RAILWAY RAILS BY MEANS OF THE ARC

The reasons for employing welding for the building up of street-railway rails, the metallurgical process involved, the technique to be used, and test results obtained are set forth in a 73-page book which comprises the Doctor thesis of Karl Tewes, prepared at the High Technical School, Berlin. The book, entitled "Building-Up Welding With the Electric Arc on Street-Railway Rails, in Dependence on the Rail Material, Additive Material, and Manner of Welding," is printed with paper binding and may be obtained from the author, Karl Tewes, Gradestr. 60/72, Berlin-Britz, Germany, at a cost of R. M. 4.50 ($1.10) plus postage.

The author deals with the chemical and physical principles involved in the building up of rails by means of welding electrodes. With high-carbon electrodes, the results obtained in the investigations were essentially different from those met with in the case of electrodes low in carbon. For example:

(1) In the melting down of the alloyed electrodes, or electrodes high in carbon, the melting-off period is 20 per cent to 30 per cent longer at the same no-load voltage and 8 per cent to 10 per cent longer at the same current strength, at the positive terminal, than at the negative terminal.

(2) At the same current strength, the amount of electrode melted down per second is less at the positive terminal than at the negative terminal. (For electrodes low in carbon the quantity molten down per second is greater at the positive terminal than at the negative terminal.)

(3) The wasting of the building-up electrode is 7 per cent to 8 per cent greater at the positive terminal than at the negative terminal, after welding.

(4) The depth of burning-in on the building-up electrode is greater in welding at the positive terminal than at the negative terminal.

Relative to the building up of street-railway rails, the material of the rails, the additive material, and the requirements of such a weld are discussed. The author states that the quality of a building-up weld can be improved by the addition of titanium to the electrodes employed.

In carying out the welding tests, the quality of the welds was affected by the guiding of the electrodes. Also, the quality of the weld, such as homogeneity and burning-in, can be improved by preheating the rails.

In the process of building up on the traveling edge or the guiding rail, it is more suitable to weld without a copper strip to form one edge of the mold, since the copper conducts away too much heat and therefore high current intensities are necessary for obtaining a burning-in.

The behavior of manganese rails in building up is also dealt with. Such rails show, in spite of their not to be denied advantages, considerable drawbacks in building-up welding, says the author, and are therefore little suited for repair by the use of the arc.

BOOK REVIEW

The fourth edition of the *Arc-Welding Manual,* published by the General Electric Co., Schenectady, N. Y., is now off the press. Its appearance within a year after the publication of the third edition was prompted by the unexpectedly great demand for the work as much as by advances in the art of arc welding during the past few months. Particularly important revisions are contained in the sections pertaining to the training of operators, automatic arc welding, atomic-hydrogen arc welding, and arc welding in steel construction. In addition to those just mentioned, other sections of the book are devoted to symbols and definitions, types of joints, expansion and contraction, weldability of metals, strength of welds, and a description of the company's apparatus for arc welding. The first section is of a general nature, treating of the arc and its characteristics, effect of impurities, and electrodes and accessories. Carbon-arc welding and electric-arc cutting are also briefly treated. One of the great features of the book is the clarity of the numerous illustrations and diagrams. The book is well bound in a flexible binding and is priced at $2.00. It is 5½x8 in. in size and contains 208 pages and an index.

ARC-WELDED BUILDING HAS WELDED STEEL DECK ROOF

The Youngstown Welding Co., Youngstown, Ohio, recently completed the erection of a crane mill-type building, the framework of which was entirely arc welded, as was also the steel deck roof. This is one of the first applications of arc welding to steel roof deck construction, although the Youngstown Welding Co. employed this type of roof for some purposes for the first time back in 1926.

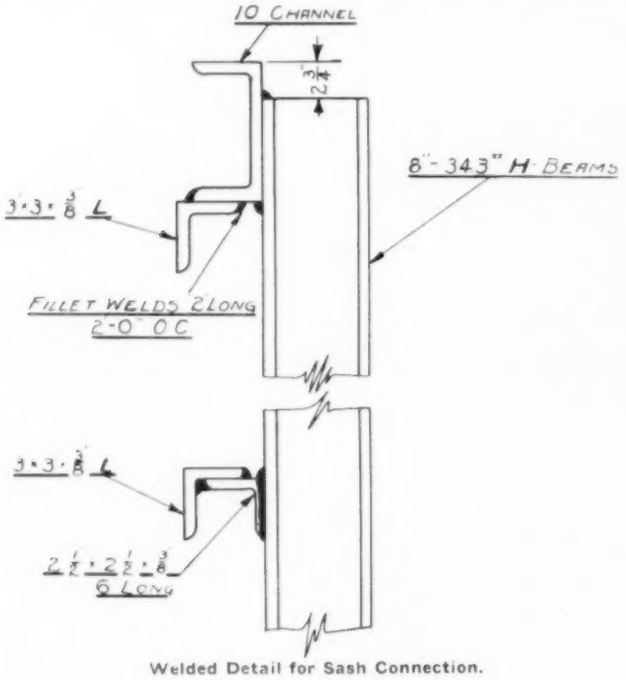
Welding Steel Deck Roof of Building.

The new building is 140 ft. long and is composed of a main bay 30 ft. wide and a side bay 20 ft. wide. One of the most interesting points in its construction is that all work was done from simple working drawings, no tracings or blueprints being made.

The columns of the main bay are 8-in. H-beams and those of the

side bay are 8-in. I-beams, all spaced at 20-ft. intervals along the length of the building. The roof girders of the main bay were constructed of steel plate and fabricated in the shops of the owners of the new building. These girders are welded to the columns and also to 9-in. pieces of 6x6x6½-in. angle, on which they rest and which in turn are welded to the columns. The roof girders of the side bay are 12-in. I-beams.

The roof is fabricated of 12-gage steel plate, arc welded into place on bar joists running longitudinally through the building.



Welded Detail for Sash Connection.

The plates overlap 1 in. The lower plate is tack welded to the joint and the overlapping plate is welded along its entire length to make the seam watertight.

C. R. Augden, assistant superintendent of the Youngstown Welding Co., was in charge of the erection of this building, and among the equipment used were several "Stable-Arc" welders manufactured by The Lincoln Electric Co., of Cleveland.

ARC WELDING HELPS TO BUILD UP LAND

The City of Galveston, Texas, which is built on land only a few feet above sea level, has suffered much damage from time to time from tidal waves and hurricanes. As a protection, the level of the land in and about the city has been gradually raised by dredging or sucking soil from the bottom of Galveston Bay, forcing it through pipe by hydraulic pressure to the exceedingly low places. In this manner, much of the land about the city has been reclaimed. To do this has required extensive dredging operations over a considerable period of time.

Fig. 3 shows a dredge barge, owned by the United Dredging Company of California, in operation in the Bay. The booms on this barge were fabricated entirely by arc welding.

A suction hood which connects the dredge pipe to the barge is shown in Fig. 1. This suction hood is built of ⅜-in. plate with circumferential seams lap welded and longitudinal seams butt welded by the electric arc process. Connection flanges at each end of the hood are also joined to the pipe by arc welding.

The dredge pipe itself, shown in Fig. 2, is formed from steel plate automatically arc welded by the Electronic Tornado process of carbon arc welding.

The pipe used to convey the sludge from the Bay to the low portions of the mainland is also of arc welded construction, being in general 24 in. in diameter and fabricated in from 20 to 60-ft. lengths. This pipe is built of ⅜-in. plate with the longitudinal seams automatically arc welded. A line of this pipe in an open trench is shown in Fig. 4. The connection flanges at the ends of each section of pipe are arc welded in place. Lines carrying the sludge often run as far as 15 miles inland.

The fabricating of both types of pipe and booms on the dredging barge was done by The Kane Boiler Works of Galveston, Texas, who utilized "Stable-Arc" welders manufactured by The Lincoln Electric Company, Cleveland, Ohio, in the fabricating process.

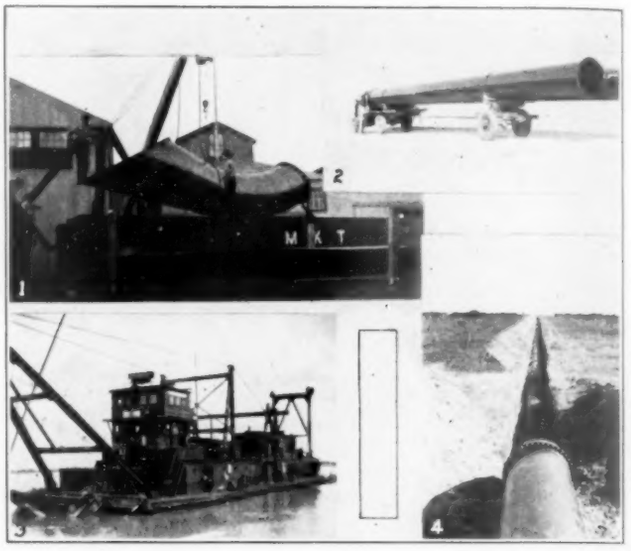


Fig. 1. Suction Hood for Use in Dredging Is Built of Steel Plate Arc Welded.
Fig. 2. Dredge Pipe of 36-Inch Diameter With Longitudinal Seam Automatically Welded by Carbon Arc Process.
Fig. 3. The Booms on This Dredging Barge Were Fabricated Entirely by Arc Welding.
Fig. 4. Showing Arc Welded Pipe Used to Convey Sludge Inland from Bay.

HUGE TRUSS FOR MAUSOLEUM NOISELESSLY FABRICATED BY WELDING

The world's heaviest welded truss was recently completed by the Pacific Iron & Steel Co., of Los Angeles, Calif., for the Forest Lawn Memorial Park Mausoleum at Glendale, Calif. It forms a part of an all-welded steel frame mausoleum extending over, but not resting on, the top of an existing building. This truss is 18 ft. high and has a span of 96 ft., as compared with the 135-ft. welded trusses of the Westinghouse Electric & Manufacturing Co.'s railroad bridge at Chicopee Falls, Mass., which served as the precedent and guide for the Forest Lawn project; but the huge Forest Lawn truss is heavier than the Westinghouse bridge trusses, it weighing 60 tons, which makes it the heaviest all-welded truss in the world.

The front of the mausoleum structure consists of two welded trusses, both smaller than the large inside truss described above. One of these trusses is 66 ft. long and the other 30 ft. The use of two trusses was possible here because the existing building was built L-shaped at this point, which allowed the erection of a column in the corner. The weight of the entire welded structure is 123 tons. "Raco" electric welding rod was used, with Westinghouse welders.

Welding was employed in the construction of these trusses chiefly to eliminate the noise that would be necessary in the case of a riveted structure. Forest Lawn Memorial Park is one of the largest and most beautiful burial parks in that part of the country, and on the average a funeral is held there about every half hour during the day. All the construction work, with the exception of the steelwork, is done by a corps of Forest Lawn workmen; and whenever there is a funeral, a siren is sounded and all noise ceases during the services. By welding this structure, there was absolutely no noise and the welders could continue with the work uninterrupted.

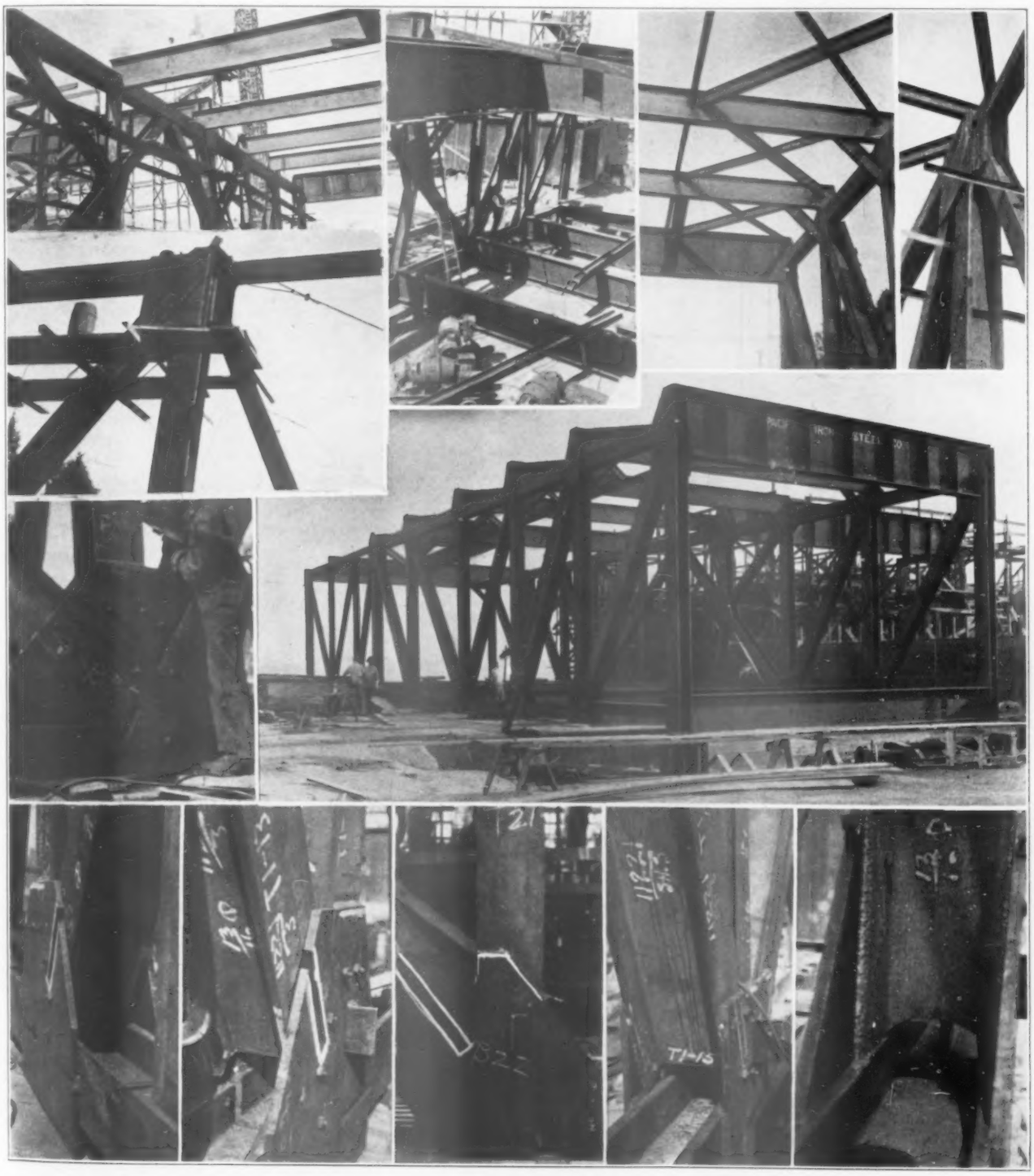
Great care had to be exercised in placing the heavy columns and beams, as one false move might cause a very serious and costly accident, in view of the fact that only a thin concrete roof protected the building below, in which were housed many tiers of caskets and very expensive statuary. To the contractors belongs the credit for erecting the structure in the allotted time and without a single accident.

H. A. Lund, of Glendale, former engineer for the owners, designed this structure. According to Gilbert D. Fish, consulting engineer of the Westinghouse Electric & Manufacturing Co., who consulted with Mr. Lund on the design of the welded joints, the use of welding instead of riveting made possible a saving of between 12 and 15 per cent in the total quantity of steel employed.

This addition to the mausoleum requires carrying very heavy dead loads above the roof of a building with no support whatever by the roof. Although the addition is only one story high, its 18-ft. height, together with the 95 ft. of clear span and the immense weight of concrete forming the mausoleum cells and encasement of steel framing, made necessary very heavy steel construction.

The 96-ft. truss has maximum chord stresses approximating 1,000,000 lb. This is believed to be the greatest load thus far transmitted by any welded joint in a building or bridge frame, and required the use of gusset plates and slot welds of uncommon dimensions.

Roof trusses of arc-welded construction have become fairly common and have generally been constructed without gusset plates.



98-Ft. Truss and Structural Details. The Chalk Lines on the Gusset Plates in the Lower Views Indicate to the Welder Where Welds Are to Be Laid.

Absence of gussets is a characteristic of light welded trusses and distinguishes them from their riveted counterparts. For trusses carrying heavy loads, the overlapping of web members on chord members does not afford sufficient room to permit development of the required strength by means of welding along the edges of the web members, and recourse must be had to gusset plates as in riveted construction. Although the general arrangement of members and gusset plates resembles riveted construction, the remarkable concentration of strength afforded by suitably designed welded joints makes possible the development of the needed strength within a space much smaller than required for a riveted joint to serve the same purpose.

To understand this point, let us consider the maximum strength concentration obtainable under usual specifications in a gusset plate with ⅞-in. rivets. The single shear value of one ⅞-in. rivet, under the specification of the American Institute of Steel Construction, is 8,100 lb. With a staggered arrangement of rivets they may be spaced so as to occupy about 6 sq. in. of plate per rivet, but this is rather too close for first-class practice. It will be seen that 1,300 lb. per sq. in. of plate is about the limiting rate of stress transfer with the ⅞-in. rivets, and that for conservative practice 1,000 lb. per sq. in. of plate is close to maximum.

Slot welds, on the other hand, readily provide for higher rates of stress transfer than the above figures. It is good practice to allow a shearing stress of 11,300 lb. per sq. in. at the bottom of a welded slot, provided the slot width be greater than the depth but not more than twice the depth (the depth of the slot is, of course, the thickness of the gusset plate). In the Forest Lawn mausoleum trusses the slots are 1¼ in. wide by 1 in. deep, the gussets being 1 in. thick. The working stress for these slot welds is 14,000 lb. per linear inch.

The minimum permissible spacing of parallel slot welds is governed by their length and the thickness of the gusset plate, because the strength of the plate metal between welds is the governing factor. For example, parallel slot welds of the section employed in this job, 8 in. long, may be used to transfer 110,000 lb. each, this stress requiring a strip of gusset plate 1 in. thick by about 6 in. wide in order to avoid excessive tension in the plate material. In the case cited, the slot welds may be spaced about 6 in. on centers, and will transfer in excess of 2,000 lb. per sq. in. of plate.

In other words, the strength of the gusset plate is the critical factor in determining the rate of stress transfer by means of slot welds. The use of high-strength steel for the gussets would permit closer spacing of welds and higher rates of stress transfer without the use of increased working stress in the welds themselves.

The gusset plates of the Forest Lawn trusses were modeled after those which were employed as an innovation on the Chicopee Falls railway bridge of the Westinghouse Electric & Manufacturing Co., near Springfield, Mass. That bridge, completed in 1928, established the practicability and economy of slot-welded gusset plates in heavy truss construction. The largest of the Forest Lawn trusses, on account of the mass of concrete which it supports, is heavier and requires heavier joints than the Chicopee Falls trusses, which were half again as long and were designed for Cooper's E50 locomotive loading.

Riveted trusses for the Forest Lawn job would have required more steel, mainly for two reasons. The gusset plates, which are a considerable item of weight even in the welded trusses, would have been larger in area and considerably heavier if used for riveted construction. The tension members, in the case of riveted construction, would have been drilled for rivet holes and would have been of considerably greater cross-section to allow for the weakening effect of the holes.

Another item of economy in welded truss construction, sometimes even more important than weight saving, is simplification or elimination of fabrication. Apart from derricks and other handling mechanisms, scarcely any tools are required for building welded trusses other than cutting torches and welding equipment. There is no need for the painstaking laying out of rivet holes and careful matching of parts in a fabricating shop to make sure that the joints fit accurately.

While it is not yet universally understood that welded construction of buildings and bridges is as definitely controllable as riveted construction, this is indeed true. Careful inspection should be provided for every important construction operation, whether of timber, reinforced concrete, riveted steel, or welded steel. Experienced inspectors of structural welding are able to judge the soundness of welded joints with at least as much certainty as rivet inspectors can judge the safety of rivets.

The growing list of welded structures, which thus far have all been successful, is gradually impressing the minds of the public and of construction men that welding, properly employed, is a means of constructing buildings and bridges safely, quickly, silently, and with saving in cost.

NEW EDITION OF ACETYLENE EQUIPMENT REGULATIONS

The National Board of Fire Underwriters has recently published a new set of regulations for the installation and operation of acetylene equipment for lighting, heating, and cooking. These regulations are now printed in a separate form, whereas in the past they have appeared together with the regulations dealing with the installation and operation of acetylene equipment generally, including welding. In this new set of regulations, the requirements relating to the storage of calcium carbide are more liberal than in the past and coincide with the regulations for the storage of carbide used for welding and cutting purposes. Copies of these rules can be obtained from the National Board of Fire Underwriters, 85 John Street, New York City, or the International Acetylene Association, 30 E. 42nd Street, New York City.

NEW HOLLUP STAINLESS ELECTRODE

This month the Hollup Corporation, Chicago, Ill., manufacturers of welding equipment and welding wire, announce the production of the Hollup coated stainless welding rod. The purpose of this new rod is to make the corrosion resisting steels such as Ascoloy, Allegheny metal, Euduro, etc., easily weldable by the application on the welding rod of a coating which has a fluxing action suitable for the various alloys. The manufacturers claim that the use of the recently perfected coating renders alloys of this type easily welded by the average operator and that it does not require expert manipulation to make sound welds without blow holes. Knowing that the arc welding of chromium iron or steel without the proper materials results in a porous, spongy weld deposit characterized by hardness and segregated lumps, the cause of this condition was studied and was determined to be due in part to the formation of a refractory chromium oxide and in part to the large quantity of oxygen absorbed by chromium alloys at or near the melting point temperature. The conditions which favor this absorption of oxygen and the formation of the refractory oxide are instability of the arc, open arc flame, and absence of scavenging agents that dissolve the chromium oxide. Therefore, in order to produce a smooth, soft and sound weld on these alloys, it is necessary to provide an agency for stabilizing the arc, protecting the arc from the effect of surrounding atmosphere and dissolving the undesirable oxide.

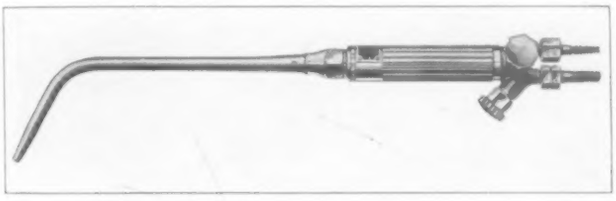
A combination of materials which will accomplish these purposes is most conveniently used in the form of a coating applied to the welding electrode. According to the Research Department of the Hollup Corporation, such a combination of coating materials should have a melting point which is at or slightly below the melting point of the chromium alloy used, since the activity of

these agents depends on the state of aggregation which is present at the time the weld is formed. It is claimed that the new Hollup electrode for stainless steels is provided with a coating which meets all these requirements. The new electrode has been subjected to a series of tests to satisfy the manufacturers as to its welding quality, ease of application, and quality of the welds produced by it.

ANOTHER NEW OXWELD BLOWPIPE

Another new blowpipe was recently announced by the Oxweld Acetylene Co., 30 East 42nd St., New York. The Type W-17, as it is called, employs the same low-pressure injector principles used in other Oxweld blowpipes. It is somewhat similar in design to the Type W-15 aircraft welding blowpipe which was introduced about a year ago. The Type W-17, however, is a full-sized blowpipe, large enough for any welding job and so carefully designed and constructed that it may be used for the finest of welding craftsmanship.

New principles of design have been incorporated in this blowpipe. The tip and welding head are of one-piece construction, being combined in a long and slender stem of the goose-neck type. Careful study has been devoted to the design of the injector and mixing chamber for each of the ten welding heads. The injector is located at the base or handle end of the stem. Each welding head has its own nut for attaching it to the handle of the blowpipe. The nut extends beyond the injector when the welding head is detached



New Injector Type Welding Blowpipe.

from the blowpipe and serves to protect the injector from damage due to careless handling. A fine-pitch thread makes it possible to tighten or loosen the nut easily without the use of a wrench. The handle of this new blowpipe is made of a special brass tubing having longitudinal ribs. This offers a sure grip to the operator and also reinforces the handle. The valve wheels are of a new design and are located so as to be readily accessible, yet out of the way during the welding operations.

This new blowpipe is compact and light. With the No. 4 welding head, it weighs but 24 ounces. The long, thin shape of the welding heads makes it possible for this blowpipe to be used in places that are not easily accessible.

The inner cone of the flame of this blowpipe is unusually short and thick and has a tendency to assume the shape of a ball at the end. This speeds up the rate of welding because a larger portion of the high temperature flame (or inner cone) surface is brought closer to the metal.

NEW FLUX ROD FOR THE CARBON-ARC WELDING OF MILD STEEL

By the use of a rod newly developed for the carbon-arc welding of mild-steel plates and castings, the welding speed can be substantially increased and there is obtained a strong and ductile deposit that is quite readily machined, says a statement from the Fusion Welding Corp., 103rd St. and Torrence Ave., Chicago, manufacturers of the new rod. This rod is known as Weldite C-No. 6 Fluxed.

The influence of the flux coating causes the arc to pull away from the hottest part of the weld puddle rather than to jump to the comparatively cold edges. Thus the arc is more easily manipulated, which feature is said to account for the greater speed.

Heavy section welding of mild steel furnishes a very favorable application for this rod, as the weld deposits are sound and strong. The ductile qualities of the deposit make the rod extremely efficient in foundry work. This rod is also said to effect substantial savings in rail-joint welding, as only one layer of deposit metal is required, and the rod may be laid in place or held in the hand as welding proceeds.

NEW WILSON 100-AMP. WELDER

To meet the need for a small, light-weight arc welder, suitable for operation in limited space, the Wilson Welder & Metals Co., Inc., 20 Wilson Bldg., Hoboken, N. J., has brought out a Type 100-Ampere machine which should prove particularly adaptable for garage work and repair work in general.

The new welder has a one-hour rating on fixed resistance, based on a 50-deg. C. temperature rise. It combines all the major operating features of the large-capacity machines with unusually light and compact construction. It has a welding range of 30 to 125 amp.

Three models are available—one with electric-motor drive, one with gasoline-engine drive, and the third arranged for belt drive.

NEW SPOT WELDER OF COMPACT AND STURDY DESIGN

The "Challenger" Model Taylor-Winfield spot and projection welding machine, which is the latest product of The Taylor-Winfield Corp., of Warren, Ohio, occupies a floor space of 25x45 in. and is 74½ in. high. Its parts are so well proportioned to withstand the heavy production for which it is designed that, notwithstanding its small size, it has a weight of 3,100 lb. This machine has four speeds, made possible by a four-speed, constant-torque motor. On slow speed with the large-size transformer and 18-in. throat depth, this machine can weld two pieces of ⅜-in. stock. On projection welding it is capable of welding five projections in an area of 7 sq. in. on ⅛-in. stock or lighter.

The transformer capacity is 40 to 80 kva. on 50- or 60-cycle curent, and 30 to 60 kva. on 25- to 30-cycle current. The transformer is of the "pancake" type, of high efficiency, and is water cooled throughout.

The motor control is incorporated in the machine base and operated by a handwheel, allowing any change to one of the four speeds to be obtained by a mere movement of the operator's wrist. Three different driving-gear sets are available, each set allowing a different speed series. The fourth-position speeds, in welds per minute, are: 45, with the No. 1 gear set; 68, with the No. 2 set; and 90, with the No. 3 set. The first-position speeds are one-third of these values, and there are two intermediate speeds.

With reference to the illustration, *D* is the four-speed driving motor and *C* the magnetic-clutch control. *A* is a nut which is adjustable for varying the welding pressure. A pressure indicator, with a graduated scale, is always in sight of the operator, and its position is indicated by *B*.

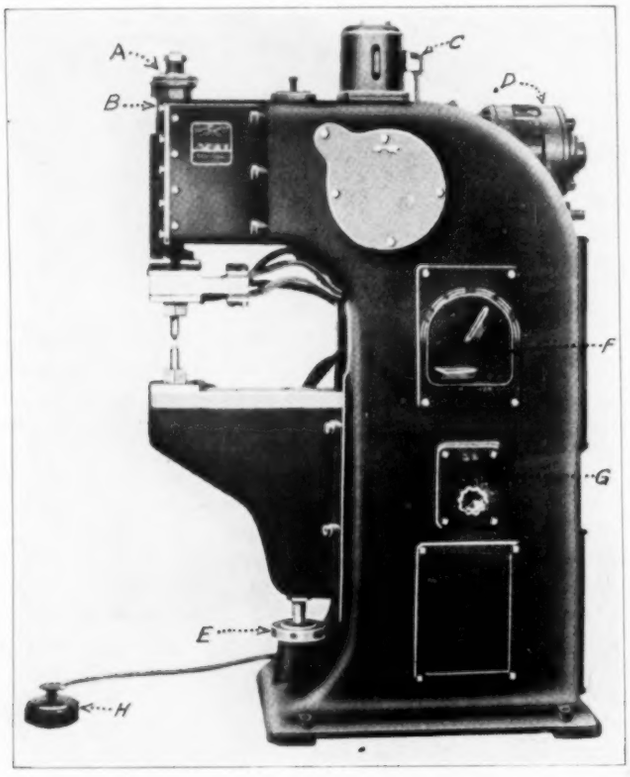
The toggle action, which actuates the operating head, gives a quiet movement. The slides are 15 in. long, with take-up gibs for alignment and wear. The lower arm has a vertical adjustment of 6½ in., the adjusting nut being indicated by *E*. There is also a visible water-flow connection in full view of the operator at all times. Throat depths can be varied from 12 up to 30 in. by using slide castings to be bolted to the main casting, or with overhang arms.

The 8-step safety selector switch, designated by *F*, effectively eliminates, it is claimed, any possiblity of short circuit or loose connections. Below this switch is the control *G* for the motor.

The remote-control switch is actuated by a graduated cam, by which the operator can vary the heat to suit the work. A special control for the cooling water allows water to flow only at the moment of welding, thus preventing the waste of water and any cooling effect that would cause condensation to form on the transformer coils.

The armored flexible-cable trip switch *H* can be moved about on the floor to the most convenient positions. An oil-level mark is provided for the clutch and transmission. The entire transmission can be removed in five minutes time. All bearings outside the transmission are fitted with oil-less bushings. The contactors are mounted in the base of the machine.

The design throughout shows that particular attention has



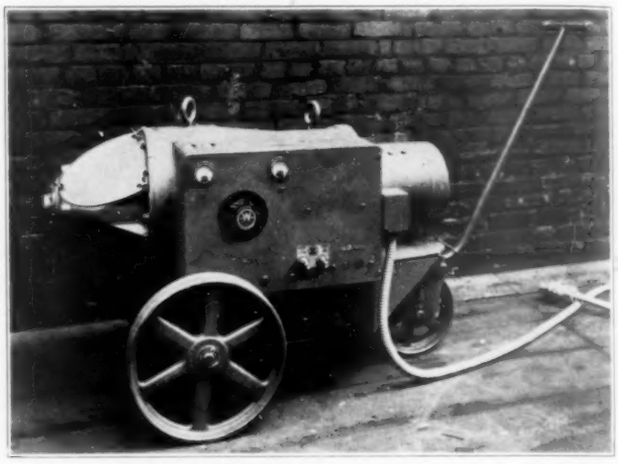
New Machine for Spot and Projection Welding.

been paid to guard the operator from possible danger and at the same time to produce a machine that is reliable in operation.

WESTINGHOUSE ANNOUNCES "FLEX-ARC" WELDERS

An important improvement in welding-machine characteristics is obtained by the use of a special piece of apparatus known as the "Flexactor," which has been developed to take the place of other types of reactors on welders. Although the principle of the "Flexactor" has been employed on the popular ratings of Westinghouse welders since the latter part of last year, only recently has the Westinghouse Electric & Manufacturing Co. announced the application of this recent development to its line of single-operator welders. The welding machines employing this new principle are known as "Flex-Arc" welders.

The chief function of the "Flexactor," it is announced, is to prevent the "overshooting" of current at the time of striking the arc, and thus to reduce the tendency of the electrode to stick. Moreover, it assists in maintaining the arc at such times when interruption is likely to occur from momentary lengthening of the arc. The explosive action and current surges caused by globules of metal passing across the arc are said to be eliminated by the "Flexactor," the effect of which is compared with that obtained with six or eight ordinary reactors. The ohmic resistance of the "Flexactor" is said to be not materially greater than that of one of the reactors formerly used in these welders. This arc stability



Westinghouse Welder With "Flexactor" Mounted Under the Frame.

and flexibility is obtained over the entire current range between extreme high and low values.

Other features of this device are its drip-proof, rugged, and compact construction, its mobility, the use of wing-nut terminals for welding-cable connections, single rheostat adjustment with calibrated dials for accurately adjusting the welding current over the entire range, and the high overall efficiency.

TWO NEW HARD FACING MATERIALS

Announcement has recently been received concerning two new materials recently put on the market by the Kayness Corp., 100 W. Monroe St., Chicago. One of these is called "Resistolite." This is a special electrode for use where resistance to abrasion is the principal requisite. It is particularly recommended for dredging machinery, oil-field tools and similar equipment. The other material is "Ketchite," a non-ferrous hard-facing alloy for use with the carbon-arc or oxy-acetylene process. The manufacturers state that this material is easily applied by either process to cutting tools or similar work and that it produces an extremely hard deposit.

NEW K-G TWO-STAGE REGULATOR

The K-G Welding & Cutting Co., New York City, has recently put on the market a new-model regulator which is called the "Waverless Flame" regulator. This is of the two-stage reduction type, assuring a steady flow of oxygen without fluctuation and safe-guarding the regulator against damage from turning on full cylinder pressure. The first-stage valve construction is said to be of an entirely new type. An interesting feature of this regulator is that the first stage is entirely separate from the second stage and in fact can be operated as a separate unit so that it can be added to any kind of regulator of the single-stage type.

BOOKLET ON WELDING-WIRE RESEARCH

Facts concerning welding wire research that every welder will find interesting are presented in a new booklet entitled "Welding Wire Research," recently published by the Page

Steel & Wire Co., 230 Park Ave., New York City. This booklet explains why ordinary wire will not do for welding, the effects of impurities on the finished weld, and why the testing procedure should be considered before judging the results from tests on such specimens. The testing of welded plate specimens is discussed. Facts concerning the use of a proper flame and a proper welding current are given in detail. The book also shows how to test welding wire by the flame test.

NEW G-E BOOKLET ON WELDING APPLICATIONS

"Arc Welding in Industry" is the title of a 40-page booklet recently completed by the General Electric Company of Schenectady, New York. The purpose of this booklet is to show the variety of important applications of electric arc welding, such as the replacement of castings, structural steel welding, tank and pressure vessel welding, pipe welding, fabrication of jigs, fixtures and dies, construction of steel floors, the welding of automobile parts, reclamation welding on railroads, cast iron welding, ship building and applications of the atomic hydrogen arc welding process. All these applications with the process are splendidly illustrated.

CONDEMNS HABIT OF CALLING OXYGEN BY THE NAME OF AIR

The widespread tendency among welders and metal cutters to call oxygen "air" has prompted the International Oxygen Co., of Newark, N. J., to broadcast among users of oxygen a small card, which fits conveniently inside any standard-size envelope, for the purpose of correcting this tendency. The card, which is in colors, contains a cartoon depicting a schoolmaster who points to a tank of oxygen and gives this admonition: "Don't call this 'air,' call it oxygen." This piece of sound advice is also included: "The practice of calling oxygen by the name of 'air' is a hazardous one. Apart from being incorrect, this custom is liable to create the impression that oxygen and air are the same and can be used for the same purpose. An error in using one for the other might result seriously."

SERIES OF BOOKLETS ON PROPERTIES AND USES OF HAYNES STELLITE

"Properties of Haynes Stellite" is the title of a 30-page booklet which is an up-to-date revision of a former pamphlet issued by the Haynes Stellite Co., Kokomo, Ind. Other booklets to follow will pertain to the procedure of applying Haynes Stellite and uses of these alloys.

The present booklet describes the various Haynes Stellite alloys, explains "red hardness" and what this characteristic means to cutting and abrasive tools and implements, enumerates some of the many uses to which these alloys have been put, gives tables of physical and chemical properties and compares these data with those of other alloys and metals, and describes the structure and crystallography of these alloys. The booklet contains many interesting illustrations.

NEW LEAFLET ON "WELDITE" RODS

The complete line of "Weldite" welding rods, including more than forty distinct types, is listed in circular A-43, published by the Fusion Welding Corp., 103rd St. and Torrence Ave., Chicago, Ill. Selection of any particular rod has been made easy by listing the rods first by the type of application, as mild steel, cast iron, etc.; second, by the process employed, as metallic arc, carbon arc, and gas; and finally by the surface finish of the rod, as bare, surfaced, or flux. General information on sizes and lengths, packing, and other details, is included.

BRITISH FIRM ISSUES HANDBOOKS ON GAS WELDING AND CUTTING

"Hints on Gas Welding" and "Hints on Oxygen Cutting" are the titles of two 64-page, 4x6½-in. booklets recently issued by The British Oxygen Co., Ltd., Angel Road, Upper Edmonton, London, N. 18, England. These booklets discuss briefly the operations involved, give hints on the manipulation of the equipment in order to insure safety to the operator and to keep the equipment in efficient working order, discuss the use of the welding and cutting flame on various metals, and describe somewhat in detail the welding and cutting equipment sold by The British Oxygen Co., Ltd. These books can be obtained from the company at 6d. (12 cents) per copy.

HAND AND POWER BENDING MACHINES

Bulletin No. 26, recently issued by Wallace Supplies Manufacturing Company, 1310 Diversey Parkway, Chicago, describes and illustrates an extensive line of machines for the cold bending of pipes, tubes, bars, rods, angles and many other shapes. There are models for hand work and power work. Items of particular interest to the job welding shop and ornamental iron shop are the hand bending machines for bending the ordinary stock shapes of rolled steel. There is a complete line of shears and cutters, a wire straightening and cutting machine, stationary and portable power saws, benches, cabinets and storage racks.

NEW ARMCO BOOKLET

The American Rolling Mill Co., Middletown, Ohio, recently issued a new 20-page booklet entitled "Pure Iron Plates for Long Service." The booklet describes the physical and commercial properties of Armco Ingot Iron and compares these properties with the properties of steel. Considerable stress is laid upon the weldability of Armco Ingot Iron. The booklet is profusely illustrated with photographs of many types of products made with this material.

VICTOR PRIZE CONTEST DRAWS REPLIES FROM ALL OVER THE WORLD

The response to a prize contest run by the Victor Welding Equipment Co., 844 Folsom St., San Francisco, Calif., in *Fusion Facts*, the monthly paper issued by the Stoody Co., of Whittier, Calif., has been so unexpectedly large that the Victor company have increased the number of prizes from the originally advertised three to a total of 40, having a value of $1,050, and including the complete Victor welding and cutting units, welding torches, cutting attachments, and the Victor aeroplane welding torches. Letters have been received from all over the world in response to this contest, which indicates how widely distributed are both *Fusion Facts* and Victor welding and cutting equipment. The company announces their intention to run an even larger contest in the near future.

ARCOS HEADQUARTERS TO BE IN PHILADELPHIA

The main office of Arcos, Incorporated, is now established in Philadelphia, in charge of R. D. Thomas, vice-president. Distributors are being appointed throughout the country as rapidly as possible. An office is also being maintained at La Crosse, Wis., which was formerly the headquarters, but it is understood that Mr. Thomas has taken over the active management of the company. The product is a line of coated electrodes, including special electrodes for welding aluminum, cast iron, and manganese steel.

NEWS OF THE INDUSTRY

Announcement has been received that the Milwaukee Welded Steel Corporation, 1350 Burnham Street, Milwaukee, Wis., are in a position to redesign cast iron bases of any type and make them out of fabricated steel, properly arc welded. The service consists of help in the matter of design as well as actual production work.

The General Petroleum Company, Los Angeles, Calif., recently utilized an accumulation of old salvaged pipe and structural iron by building an all-welded crane for loading pumps and other heavy equipment. The crane was built to handle three tons, but owing to its welded construction, it easily handles twice the intended capacity.

The Linde Air Products Company and Associated Companies will occupy Booth No. 281 at the Oil Equipment and Engineering Exposition to be held at the Shrine Auditorium, Los Angeles, California, on March 16 to 23 inclusive. A full line of Oxweld and Prest-O-Weld Welding and Cutting Apparatus will be on display as well as Oxweld Acetylene Generators, Linde Oxygen and Prest-O-Lite Acetylene. Union Carbide in drums will also be a part of the display.

The Technical Committee on Welding for the Society of German Engineers has issued temporary guide specifications for use in welding structural steel, according to the *VDI-Zeitschrift*.

Welded Shipbuilders, Ltd., of Wilmington, Los Angeles, Calif., is planning a new shipbuilding plant at Wilmington harbor, with equipment to include semi-automatic and automatic welding, to cost over $150,000 complete. This company is a subsidiary of the Los Angeles Manufacturing Co.

A. W. Swift, formerly Associate Editor of The Welding Engineer, recently resigned this position to accept the position of Assistant Sales Manager of the Sight Feed Generator Company, West Alexandria, Ohio, effective March 1st.

The Harris Calorific Company has announced the appointment of the Allweld Company, Boston, Mass., as their distributor for that territory. The Allweld Company is under the management of Mr. L. T. S. Ellis.

The Shockey Boiler Works of San Diego, California, report a very good record in fuel oil tank building, having in the past few months furnished "tailor made" fuel tanks for over 30 boats of various sizes in that harbor, ranging from 8,000 to 17,000 gallons capacity. Mr. Shockey predicts a great future in welded fuel oil tank building, and has recently backed his judgment along this line to the extent of purchasing a new Westinghouse arc machine to be used in this work.

Mr. Otto Frederiksen of San Diego, Calif., who recently purchased the plant known in the past as the Huston Welding Co., will in the future operate under the name of the San Diego Welding Co., with an up-to-date shop, giving 24-hour service. They expect to specialize in oil field work, covering the Ensenada and Lower Borderland fields which are at this time attracting considerable attention in that section of Southern California.

A new booklet recently issued by the Passaic-Bergen Welding Works, 646 Main Avenue, Clifton, N. J., carries the interesting title "Welding An Art." In addition to showing by means of a number of photographs the many possibilities which there are for a commercial welding shop to serve industrial plants, the booklet contains a considerable amount of information concerning welding apparatus and supplies which are sold by the company. Mr. Frank W. Taft, General Manager of the company, states that 5,000 of these catalogues are being distributed in his territory.

L. R. McKean, Manager of the Harris Sales Company, 1139 S. 58th Street, Philadelphia, Pa., reports a high production activity in several aircraft plants in that district and mentions another large user of welding which expects to have a new ten million dollar plant in operation by the middle of this month.

Edward C. Madison, formerly with Wilson Welder & Metals Company, has been appointed Vice-President of Prest-O-Sales & Service, Inc., Long Island City, who are distributors of a complete line of electric welding and oxy-acetylene welding equipment and supplies.

Victor Welding Equipment Company will have a very interesting exhibition at the Oil Equipment and Engineering Exposition in the Shrine Auditorium, Los Angeles, Calif., this month. A complete line of welding, cutting, heating and brazing equipment will be shown at the Victor booth, which is No. 121.

D. B. Mans, engineer for the Shell Petroleum Corporation at Long Beach, California, is an observer in the technique of gas and electric welding in the plant of the H. C. Smith Manufacturing Co., manufacturers of oil well drilling tools at Los Nietos, California, through courtesy of the Smith Company. Mr. Mans is preparing for foreign service with the Shell Corporation, and will leave early in June for Borneo in the capacity of mechanical engineer.

Sam Hord, President of the Wichita Falls Oxygen Company, Wichita Falls, Texas, has sent in a newspaper account illustrating the completion of the final work on the new thirty-mile Waggoner pipe line as it reached the refinery district of Wichita Falls on February 18th. The estimated cost of an installation of this kind was $150,000, and its purpose was to supply the independent dealers of Wichita Falls with a practically unlimited supply of crude oil. The capacity of the line will approximate 15,000 barrels a day. The contractor for the construction of the line was W. F. Fullerton of Wichita Falls. The work was completed in fifteen working days—an average of two miles of completely welded pipe each day.

R. K. Randall, Manager of the Cleveland Welding School, writes that the school has recently increased its capacity for instruction in electric welding by the installation of a new Hansen arc welder.

Miles C. Smith, Manager of Sales Promotion of the Stoody Company, Whittier, Calif., was a visitor in Chicago during the week of March 10th. Mr. Smith reports a constantly increasing interest in the application of Stoody hard facing materials in all territories which he has visited on this trip.

Dr. E. R. Weidlein, Director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced the appointment of H. E. Foote (Ph.D., Brown University, 1917) to the incumbency of the Institute's Industrial Fellowship on Oxygen. This Fellowship has been established by the Gas Industries Company, Inc., Pittsburgh, Pa., designer and builder of liquid-air oxygen apparatus. The investigation is to be concerned with the extension of the present uses of oxygen, and in particular with the application of cheap oxygen in various industrial processes, including metallurgical operations and technically important organic oxidation reactions. Dr. Foote has been a member of the Institute's investigational staff since 1927. He was previously engaged in research at the Philippine Bureau of Science, Manila, P. I.